(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 174 862 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
21.06.2006 Bulletin 2006/25

(51) Int Cl.:
G11B 7/125 *(2006.01)* ***G11B 7/00*** *(2006.01)*

(21) Application number: **01114669.3**

(22) Date of filing: **19.06.2001**

(54) Optical disc recording method and apparatus

Aufzeichnungsverfahren und -Vorrichtung für optische Platte

Procédé et appareil d'enregistrement de disque optique

(84) Designated Contracting States:
BE DE FR GB IT NL

(30) Priority: **19.06.2000 JP 2000183780**

(43) Date of publication of application:
23.01.2002 Bulletin 2002/04

(60) Divisional application:
05022615.8 / 1 615 211

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- **PATENT ABSTRACTS OF JAPAN vol. 1999, no. 09, 30 July 1999 (1999-07-30) -& JP 11 102522 A (NEC CORP), 13 April 1999 (1999-04-13)**
- **PATENT ABSTRACTS OF JAPAN vol. 016, no. 555 (P-1454), 25 November 1992 (1992-11-25) -& JP 04 209318 A (SHARP CORP), 30 July 1992 (1992-07-30)**

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates to an optical disc recording method apparatus of a mark length recording system in which the laser light is illuminated on a recording surface of an optical disc to form pits for information recording. More particularly, it relates to a method and apparatus for recording an optical disc in which recording is made at a speed higher than a quadrupled speed, such as octupled or duodeca-tupled speed.

Description of Related Art

[0002] Up to now, in recording the information on a recording medium, such as an optical disc, in accordance with an optical modulation system, thermal control is exercised by pulsed light emission of the laser in order to form pits (marks) optimally on a disc. Specifically, the pulse waveform is set as a driving pulse for driving the laser, while the level (wave crest value) during each pulse period is also controlled to control the laser power and the laser illuminating period.

[0003] For example, in an optical recording and/or reproducing apparatus, typified by a CD-R (CD-Recordable) or CD-RW (CD-ReWritable), a pulse length controlling system or a pulse train recording system is used, in which the pulse length or the number of pulses of the laser light illuminated is varied depending on the recording mark length or space length to be recorded to control the laser power outputting domain.

[0004] The Orange-Book Part 2 (version 3.1), as the latest standard of CD-R, is premised, as the standard per se, on the mono-tupled speed, double-speed and quadrupled speed recording. The laser light emission control related to the write speed, that is recording strategy (recording compensation) is prescribed as shown in Figs. 1 and 2. That is, in the CD-R standard, the information is recorded on an optical disc by the combination of pits (marks) and lands (spaces) of 3T to 11T. For the recording strategy for mono-tupled speed and double-speed recording, the laser power outputting domain of $(n-\theta)T+\alpha T$ is prescribed, where $\theta = 1T$ and $\alpha = 0.13T$, with the laser power forming nT pits (marks) being Pw, as shown in Fig.1. For the recording strategy for quadrupled speed recording, $(n-\theta)T$ and ODT are prescribed as being output domains of the laser power Pw and the laser power ΔP, respectively, with the laser power forming nT pits (marks) being $Pw+\Delta P$, where ΔP is 20 to 30% of Pw and ODT is set to 1.25T to 1.5T. It is noted that the mono-tupled speed herein means a speed of 1.2 to 1.4 m/s with the disc being run in rotation at a constant linear velocity (CLV).

[0005] Meanwhile, if the recording strategy prescribed by the above-mentioned Orange Book standard, premised on the mono-tupled speed recording, double speed recording and on the quadrupled speed recording, is to be applied to recording at a speed higher than the quadrupled speed, such as octupled speed recording or duodeca-tupled speed recording, thermal interference occurs between the pit and land codes to be recorded, with the result that recording signals are deteriorated in signal quality due to deformed pit shape or to increased jitter.

[0006] That is, the ideal relation between recording data and pits is such that, for recording data with a length equal to nT, a pit with a length equal to nT is formed to an oblong shape, as shown in Fig.3. If now the octupled speed recording, for example, is to be made with the recording strategy for mono-tupled speed recording and double speed recording, a tear-shaped pit is formed in which the trailing end side of the pit is spread in a direction perpendicular to the track center, as shown in Fig.4. If the recording strategy for quadrupled speed recording is used, there is again formed a tear-shaped pit which is only slightly improved over the case of the octupled speed recording as to spreading of the pit in the direction perpendicular to the track center, as shown in Fig.5.

[0007] In Figs.4 and 5, the time periods A and B denote time delay as from the turning on of the laser emission until start of the pit forming process. On the other hand, the time periods a, b and c denote time delay as from the turning off of the laser light emission until termination of the pit forming process.

[0008] If the recording signal is deteriorated in quality due to deformed pit shape or increased jitter, there is a risk that regular reproduction cannot be realized.

[0009] An optical disc recording apparatus in which all features of the precharacterizing part of claim 1 are disclosed, is described in EP-A-0 932 144.

[0010] Further, there is known from EP-A-0 388 897 an optical disc recording method in which series of succeeding recording pulses is generated for each pit representing the optical disc data, wherein, in the series of pulses, the width of the pulses is varied in order to reduce influence of heat remaining from previous pit writing and to improve quality of recording signals.

SUMMARY OF THE INVENTION

[0011] It is an object of the present invention to provide an optical disc recording method and apparatus whereby pits

can be formed to an optimal shape at a speed faster than the quadrupled speed, such as an octupled speed or duodeca-tupled speed.

[0012] This object is achieved by an optical disc recording method and an optical disc recording apparatus according to the enclosed independent claims. Advantageous features of the present invention are defined in the corresponding subclaims.

[0013] According to the present invention, it becomes possible to reduce thermal interference due to inter-symbol interference between the codes, that is the pits and the lands recorded, with the result that pits/lands may be formed to an optimum shape to enable a sufficient replay margin to be produced even at a high-speed recording such as octupled speed recording. In addition, the recording quality may be improved through reduction in the recording jitter.

[0014] That is, with the present invention, recording with optimal pit shape may be achieved at a speed higher than the quadrupled speed, such as at an octupled or duodeca-tupled speed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Figs. 1A and 1B show waveform diagrams showing recording strategies in mono-tupled speed recording and double speed recording as prescribed in the Orange-Book standard.
Figs.2A and 2B are waveform diagrams showing a recording strategy in quadrupled speed recording as prescribed in the Orange-Book standard.
Figs.3A and 3B illustrate an ideal recording state.
Figs.4A and 4B illustrate pit distortion in octupled speed recording using the recording strategies in mono-tupled speed recording and double speed recording.
Figs.5A and 5B illustrate pit distortion in octupled speed recording using the recording strategy in quadrupled speed recording.
Fig.6 is a block diagram showing a structure of an optical disc recording and/or reproducing apparatus embodying the present invention.
Fig.7 is a waveform diagram showing the recording strategy as used in the optical disc recording and/or reproducing apparatus shown in Fig.6.
Fig.8 is a block diagram showing a specified illustrative structure of a recording pulse generating circuit in the optical disc recording and/or reproducing apparatus shown in Fig.6.
Fig.9 is a waveform diagram showing the recording operation by the optical disc recording and/or reproducing apparatus shown in Fig.6.
Fig. 10 is a graph showing measured results of replay 3T pit jitter characteristics obtained on octupled speed recording on a CD-R disc coated with a cyanine-based organic dyestuff.
Fig.11 is a graph showing measured results of replay 3T land jitter characteristics obtained on octupled speed recording on a CD-R disc coated with a cyanine-based organic dyestuff.
Fig.12 is a graph showing measured results of replay 3T pit jitter characteristics obtained on octupled speed recording on a CD-R disc coated with a phthalocyanine-based organic dyestuff.
Fig.13 is a graph showing measured results of replay 3T land jitter characteristics obtained on octupled speed recording on a CD-R disc coated with a phthalocyanine-based organic dyestuff.
Fig. 14 is a wavefonn diagram showing a modification of a recording strategy as used in the optical disc recording and/or reproducing apparatus shown in Fig.6.
Fig.15 is a block diagram of a recording laser power controlling system embodying another example.
Figs.16A to 16E illustrate recording laser patterns and driving pulses embodying said another example;
Figs.17 to 22 illustrate typical recording laser patterns embodying said another example.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] Referring to the drawings, preferred embodiments of the present invention will be explained in detail.

[0017] The present invention is applied to an optical disc recording and/or reproducing apparatus 100 configured as shown for example in Fig.6.

[0018] The optical disc recording and/or reproducing apparatus 100, shown in Fig.6, is a disc drive of the mark length recording system in which a CD-R (CD-Recordable), that is a write-once optical disc 1, is run in rotation at a CLV by a spindle motor 2, and in which the laser light is illuminated on the recording surface of the optical disc 1 by an optical head 3 to form pits to effect data recording and/or reproduction. The optical disc recording and/or reproducing apparatus 100 includes a servo circuit 4, connected to the spindle motor 2 and to the optical head 3, a recording pulse generating circuit 5, connected to the optical head 3, a replay signal processing circuit 6, similarly connected to the optical head 3,

an encoder/decoder circuit 7, connected to the recording pulse generating circuit 5 and to the replay signal processing circuit 6, an SCSI interfacing circuit 8, connected to the encoder/decoder circuit 7, and a system controller 9 connected to the servo circuit 4, encoder/decoder circuit 7 and to the SCSI interfacing circuit 8, and is connected to an external host computer 10 through the SCSI interfacing circuit 8.

[0019] The servo circuit 4 is controlled by the host computer 10 as to a control operation conforming to a control command supplied from the host computer 10 through the SCSI interfacing circuit 8. The servo circuit 4 driving-controls the spindle motor 2 to cause the rotation of the optical disc at the CLV, so that, during data recording and/or reproduction, a target area on the recording surface of the optical disc 1 will be accessed by the optical head 3. The servo circuit 4 also controls the optical head 3 as to its feed, focusing and tracking.

[0020] In this optical disc recording and/or reproducing apparatus 100, data to be written is sent from the host computer 10 through the SCSI interfacing circuit 8 to the encoder/decoder circuit 7 where the data to be written is encoded into signals of the desired data format, for example, EFM signals, so as to be sent to the recording pulse generating circuit 5.

[0021] The recording pulse generating circuit 5 in the optical disc recording and/or reproducing apparatus 100 performs recording strategy (recording compensation) processing on the EFM (eight-to-fourteen modulated) signals, supplied from the encoder/decoder circuit 7, depending on dye materials of the recording medium, material type of the reflecting film, linear speed, or on recording speed characteristics of the optical system of the recording and/or reproducing apparatus, to generate recording pulses.

[0022] Fig.7 shows typical recording pulses generated by the recording pulse generating circuit 5.

[0023] In Fig.7, the recording pulses ODT1 and ODT2 are variably set in the ranges of

$$\mathrm{OT} \le \mathrm{ODT1} \le 3.0\mathrm{T},\ \mathrm{Pw}{*}0.0 \le \Delta\mathrm{P1} \le \mathrm{Pw}{*}0.5$$

$$\mathrm{OT} \le \mathrm{ODT2} \le 3.0\mathrm{T},\ \mathrm{Pw}{*}0.0 \le \Delta\mathrm{P2} \le \mathrm{Pw}{*}0.5$$

within a recording pulse outputting period of 3T to 11T. It is noted that ODT1, ODT2, ΔP1 and ΔP2 are related to one another by

$$\mathrm{ODT1} \ge \mathrm{ODT2}$$

$$\Delta\mathrm{P1} \ge \Delta\mathrm{P2}.$$

[0024] Meanwhile, the outputting periods of the recording pulses ODT1 and ODT2 can be independently varied for each of the recording pulses 3T to 11T, if the relationship:

$$\mathrm{ODT1}_{(3T)} \ge \mathrm{ODT1}_{(4T)} \ge \cdots\cdots \mathrm{ODT1}_{(11T)}$$

$$\mathrm{ODT2}_{(3T)} \ge \mathrm{ODT2}_{(4T)} \ge \cdots\cdots \mathrm{ODT2}_{(11T)}$$

is maintained.

[0025] It is noted that, in recording on a recording medium, such as an optical disc, in accordance with the optical modulation recording system, the shorter the length of a land (space) lying directly ahead of the pit to be recorded, the more likely the thermal interference is produced, because the heat accumulated in recording the directly previous pit (mark) is not dissipated sufficiently. With the present recording pulse generating circuit 5, the pulse lengths of the respective pulses can be variable optionally and independently by proper combinations of the pits (marks) and lands (spaces) to be recorded, thereby varying the recording pulse length such as to optimize the replay signal following the

recording.

[0026] The recording pulses, generated by the recording pulse generating circuit 5, are furnished to a laser diver circuit 30 for laser driving, enclosed in the optical head 3. The laser diode is driven by the laser diver circuit 30 in accordance with the logic of the recording pulses to cause the laser diode to emit light to record data on the optical disc 1.

[0027] The recording pulse generating circuit 5 for superposing two-step stacking portions ΔP1, ΔP2 at approximately the leading end of an EQEFM recording pulse V1 by the recording strategy processing to generate the recording pulse V1 includes a pit/land length detection circuit 51, an EQEFM generating circuit 52, an ODP1 generating circuit 53 and an ODP2 generating circuit 54, as shown for example in Fig.8.

[0028] In this recording pulse generating circuit 5, the pit/land length detection circuit 51 detects the pulse width of the EFM signal sent from the encoder/decoder circuit 7 and directly previous pit and land lengths. The EQEFM generating circuit 52 generates an EQEFM recording pulse V1 of a pre-set level and pulse width derived from the EFM signal, while the ODP1 generating circuit 53 generates an ODP1 recording pulse V2 to be added to approximately the leading end of the laser driving pulse and the ODP2 generating circuit 54 generates an ODP2 recording pulse V3 to be added to approximately the leading end of the laser driving pulse. The recording pulses V1, V2, V3, generated by the EQEFM generating circuit 52, ODP1 generating circuit 53 and the ODP2 generating circuit 54, respectively, are variably controlled as to the pulse widths or pulse levels (voltage levels) depending on the pulse width of the EFM signal detected by the pit/land length detection circuit 51 or on directly previous pit lengths or land lengths.

[0029] It is noted that switches SW1, SW2 and SW3 are changeover circuits for enabling/disabling the recording pulses, ODP recording pulses V2 and ODP recording pulses V3, respectively, and are controlled by the system controller 9.

[0030] That is, the system controller 9 is responsive to the write command and the mode setting command sent from the host computer 10 to recognize with which multiple speed the recording data transferred from the host computer 10 is to be recorded on the disc. The switches SW1, SW2 and SW3 are changed over responsive to the write speed as required. For example, if the write speed is mono-tupled or double speed, the switches SW2 and SW3 are turned off to disable the ODP1 generating circuit 53 and the ODP2 generating circuit 54 so that ODP recording pulses V2 or ODP recording pulses V3 are not added as the recording pulse as shown in Fig. 1. If the write speed required is the quadrupled speed, only the switch SW3 is turned off so as not to permit the ODP recording pulse V3 to be added as the recording pulse shown in Fig.2. In recording data with the octupled speed or duo-deca-tupled speed, as in the present invention, the switches SW1, SW2 and SW3 are all turned on to permit the recording pulse shown in Fig.7 to be output.

[0031] The recording pulses V1 to V3, generated in the recording pulse generating circuit 5, are sent to the laser diver circuit 30 enclosed in the optical head 3. The laser diode LD is driven by the laser diver circuit 30 in accordance with the logic of each recording pulse to cause the recording laser to emit light to record data on the optical disc 1. In the laser diver circuit 30, the recording pulses V1 to V3, generated by the ODP1 generating circuit 52, ODP1 generating circuit 53 and the ODP2 generating circuit 54, are converted by current/voltage converting circuits 31 to 33 into recording current signals I1 to I3, respectively, which are summed and synthesized together by an addition circuit 34 to generate a driving current i (=I1 + I2 + I3) which then is caused to flow through the laser diode LD to drive the laser diode LD to cause the recording laser to emit light to record data on the optical disc 1.

[0032] That is, in this recording pulse generating circuit 5, the driving current i, obtained on summing the recording pulses V1 to V3, generated in the recording pulse generating circuit 5, as current values, is caused to flow through the laser diode LD, and the recording laser of the light emission waveform having two-step stacked portions ΔP1 and ΔP2 in approximately the leading edge of the EQEFM signal is illuminated from the laser diode LD on the recording surface of the optical disc 1, as shown in Fig.9, to form a track comprised of a pit and a land on the recording surface.

[0033] In Fig.9, the time period C indicates the time delay since the turning on of the laser light emission until a pit starts to be formed, while the time period c indicates the time delay since the turning off of the laser light emission until the pit has been formed. The time periods C and c may be represented by

$C<B<A$ and

$c<b<a$,

where the time periods A and a are time periods in case recording is made using the recording strategy for mono-tupled and double speed recording, as shown in Fig.4, and the time periods B and b are the time periods in case recording is made using the recording strategy for quadrupled speed recording, as shown in Fig.5. That is, the above time period C and c are shorter than the time periods A and a or B and b.

[0034] Thus, with the optical disc recording and/or reproducing apparatus 100 according to the present invention, pits/lands can be produced which are adapted more accurately to the EFM signals in high-speed recording.

[0035] In this optical disc recording and/or reproducing apparatus 100, in which the driving current i is generated by summing the ODP recording pulse V2 and ODP recording pulse V3 to the EQEFM recording pulse V1, the levels or the pulse widths of the pulses V1 to V3 are varied depending on the recording conditions, or on pulse widths of the EFM signals detected by the pit/land length detection circuit 51 or directly previous pit or land length, with the pulse length being optionally and independently set responsive to each of the durations of 3T to 11T.

[0036] In actuality, the pulse width or the pulse level is adjusted depending on such conditions as the disc material type (type of the dye film material), disc makers, recording linear velocity or optical properties of the optical head.

[0037] In particular, in view of difference in the thermal reaction caused by the difference in the type of the dye material, it is effective to check for the type of the disc loaded in recording or the disc producer to adjust the pulse width or level. It is similarly effective for the recording operation to adjust the pulse width or level after the start of the recording.

[0038] Of the cyanine-based or phthalocyanine-based disc, characteristics of the replay 3T pit/land jitter were measured, and the results shown in Figs. 10 to 13 were obtained.

[0039] Figs.10 and 11 show measured results of replay 3T pit jitter characteristics and replay 3T land jitter characteristics, obtained on octupled speed recording on a CD-R medium coated with the cyanine-based organic dye. Figs.12 and 13 show measured results of replay 3T pit jitter characteristics and replay 3T land jitter characteristics, obtained on octupled speed recording on a CD-R medium coated with the phthalocyanine-based organic dye. In Figs. 10 to 13, the abscissa and the ordinate denote the recording power and the RF jitter contained in the replay RF signals.

[0040] In Figs. 10 to 13, the measured results in case recording is effected for $\theta = 0.25$, $\alpha = 0.13T$, using the recording strategy for conventional mono-tupled and double speed recording shown in Fig. 1, those in case recording is effected for $\theta = 0.25$, $\alpha = 1.50T$ and $\Delta P = 30\%$, using the recording strategy for conventional quadrupled speed recording shown in Fig.2, and those in case recording is effected on the optical disc recording and/or reproducing apparatus 100 of the present invention with the optimized pulse lengths of the respective recording pulses, are indicated by ■,▲ and ● respectively.

[0041] As may be seen from the measured results of the replay 3T pit/land jitter characteristics, shown in Figs.10 to 13, the post-recording pit/land jitter is improved significantly, without regard to the type of the organic dye material or the recording medium used, whilst the lowering in the power margin of the jitter with respect to the recording power or in the recording power may be prohibited appreciably.

[0042] In the above-described optical disc recording and/or reproducing apparatus 100, the recording laser light comprised of the EQEFM recording pulse V1, on approximately the leading edge of which $\Delta P1$ and $\Delta P2$ are stacked, is adapted to emit light. Alternatively, such a recording strategy may also be used in which the recording pulse generating circuit 5 generates the EQEFM recording pulse V1 and m sorts of ODP1 recording pulses, namely the ODP1 recording pulse V1 to ODPm recording pulse Vm, with pulse widths of L1 to Lm, to cause the recording laser of a waveform having the m-stage stacked portions $\Delta P1$ to ΔPm at approximately the forward end of the EQEFM recording pulse V1 to emit light to effect recording, as shown in Fig.14.

[0043] The components of a modified example of a disc drive device responsible for generating laser driving pulses at the time of recording are extracted and shown in Fig.15. Meanwhile, the overall structure of the disc drive device is similar to that of the first embodiment shown in Fig. 1.

[0044] During recording, the EFM signals from the encoder/decoder circuit 7 are sent to a recording pulse generator 121 which is made up of a pit/land length detection circuit 131, an end pulse generating circuit 132, a first pulse generating circuit 133 and an EQEFM generating circuit 134.

[0045] The EQEFM generating circuit 134 generates an EQEFM signal V11 of a pre-set level and a pulse width derived from the EFM signal.

[0046] The first pulse generating circuit 133 generates a first over-drive pulse V21 to be added to approximately the leading end of a laser driving pulse.

[0047] The end pulse generating circuit 132 generates an end over-drive pulse V31 to be added to approximately the trailing end of the laser driving pulse.

[0048] The end pulse generating circuit 132, first pulse generating circuit 133 and the EQEFM generating circuit 134 generate respective pulses V11, V21 and V31 with pulse widths corresponding to the pulse width of the EFM signal. The pulse width or the pulse level (voltage level) is variably controlled depending on the current pulse width or the directly previous pit or land length of the EFM signal as detected by the pit/land length detection circuit.

[0049] The switches SW1, SW2 and SW3 are changeover circuits for enabling/disabling the EQEFM signal V11, first over-drive pulse V21 and the end over-drive pulse V31, and are controlled by the system controller 9. That is, the system controller 9 is responsive to the write command or the mode setting command sent from the host computer 10 to recognize with which multiple speed the recording data transferred from the host computer 10 is to be recorded on the disc. The system controller 9 changes over the switches SW1 to SW3 depending on the write speed as required. For example, if the write speed is the mono-tupled or double speed, the system controller 9 disables the first pulse generating circuit 133 and the end pulse generating circuit 132 by turning the switches SW2 and SW3 off so as to preclude the appendage of the first over-drive pulse V21 and the end over-drive pulse V31, as indicated by the drive pulse shown in Fig. 1. If the write speed as requested is the quadrupled speed, only the switch SW3 is turned off to preclude the outputting of the end over-drive pulse V31 as indicated by the drive pulse shown in Fig.2. In recording the data at an octupled speed, as newly proposed in accordance with the modified example all of the switches SW1, SW2 and SW3 are turned on to output a drive pulse as indicated in Figs.17 to 22.

[0050] The EQEFM signal V11, first over-drive pulse V21 and the end over-drive pulse V31 are converted respectively

into current signals i11, i21 and i31 in the current/voltage converting circuits 137, 136, 135 in laser diver circuit 30.

[0051] In the addition circuit 138, the current signals i17, i27 and i37 are added to give the driving current i applied to the laser diode LD.

[0052] Meanwhile, in the modified example control signals from the system controller 9 are input to the voltage/current converting circuits 137, 136, 135. That is, if the level (amplitude) of each pulse is to be changed depending on e.g., the rotational speed of the disc (linear speed relative to the track) during recording, length of the pit recorded, the material type of the recording layer (dye layer) used in the disc, or ambient temperature, control signals or parameters are input by the system controller 9. Thus, the level (amplitude) of the respective signals V11, V21, V31 is individually controlled by parameters applied to the voltage/current converting circuits 137, 136, 135. Although the voltage/current converting circuits 137, 136, 135 are provided in the modified example with the level adjustment function, it is also possible to provide a level adjustment circuit upstream or downstream of the voltage/current converting circuits 137, 136, 135 as a separate circuit.

[0053] The laser power controlled in the present stricture is as follows:

[0054] Figs.16C,16D and 16E show specified examples of the end over-drive pulse (ODP END;V31), first over-drive pulse (ODP FIRST; V21) and EQEFM signal V11, respectively.

[0055] The laser power output by the driving current i, corresponding to the current values rendered from the signals V11, V21 and V31 and summed together, is as shown in Fig.16A. That is, the power by the first over-drive pulse is summed to the leading end of the EQEFM signal, whilst the power by the over-drive pulse is summed to the trailing end. It is noted that Pr, Pw and Pod are the replay laser level, recording laser level and the laser level by the over-drive pulse, respectively.

[0056] By the output laser power of the laser diode LD being controlled in this manner, a track by the pit P and the land L is formed on the disc 1, as shown in Fig. 16B.

[0057] In Fig. 16, the time period C denotes the time delay as from the turning on of the laser light emission until the pit P starts to be formed, whilst the time period c denotes the time delay as from the turning off of the laser light emission until the end of forming of the pit P.

[0058] These time periods C and c are shorter than the time periods A, B, a and b shown in Fig.5, meaning that, in the modified example the pits/lands coping accurately with the EFM signals can be formed even in recording at a high speed.

[0059] In the modified example the end over-drive pulse and the first over-drive pulse are summed to the EQEFM signals to generate the driving signal i. The EQEFM signals end over-drive pulse and the first over-drive pulse, generated by the recording signal generating unit 121, can be varied in level or pulse width depending on the pit or land length of the fore and aft side pits and lands as detected by the pit/land length detection circuit. The system controller 9 optionally variably sets the pulse width depending on the different pulses 3T to 11T.

[0060] That is, the pulse width is basically the pulse of (N-X(N))T pulse for the N(T) EFM pulse.

[0061] That is, the values X3 to X11 for setting the pulse widths of the EQEFM signal are optionally respectively set depending on the respective pulses of 3T to 11T.

[0062] For example, Fig.16A is associated with the EFM signals of Fig.3A, whereas EQEFM signal with the pulse width of (3-X3)T pulse width is generated during the 3T pulse period of the EFM signals. Also, during the 11T pulse period, the EQEFM signal with the pulse width of (11-X11)T is generated.

[0063] That is, the pulse width is controlled in accordance with the different in the pulse width, that is the difference in the heat storage on the recording track caused by the difference in the laser illuminating time period, thus enabling the pits/lands suitably conforming to the EFM signals.

[0064] By way of an example, the values of X3 to X11 may take on the values of 0.25 to 0.2.

[0065] To the EQEFM signal are summed the first over-drive pulse and the end over-drive pulse. As the synthesized waveform pattern (laser output level control pattern), a variety of patterns as shown for example in Figs.17 to 22 may be used. In Figs.17 to 22, L1 and L2 denote pulse widths of the first over-drive pulse an the end over-drive pulse, respectively.

[0066] Fig.17 shows a case in which L1 = L2 and in which the rising of the first over-drive pulse and the decay of the EQEFM signal are synchronized with the EQEFM signal.

[0067] Fig.18 shows a case in which L1 < L2 and in which the rising of the first over-drive pulse and the decay of the EQEFM signal are synchronized with the EQEFM signal.

[0068] Fig.19 shows a case in which L1 > L2 and in which the rising of the first over-drive pulse and the decay of the EQEFM signal are synchronized with the EQEFM signal.

[0069] Fig.20 shows a case in which L1 = L2 and in which the rising of the first over-drive pulse is earlier than the EQEFM signal and the decay of the end over-drive pulse is later than the EQEFM signal.

[0070] Fig.21 shows a case in which L1 < L2 and in which the rising of the first over-drive pulse is synchronized with the EQEFM signal and the decay of the end over-drive:pulse is later than the EQEFM signal.

[0071] Fig.22 shows a case in which L1 > L2 and in which the rising of the first over-drive pulse is earlier than the

EQEFM signal and the decay of the end over-drive pulse is synchronized with the EQEFM signal.

[0072] In all of these figures, it is possible to realize a laser light emission pattern as indicated as an LD light output.

[0073] Other patterns than these may, of course, be realized.

[0074] The respective patterns may be selectively used, in particular the time periods L1 and L2 may be set, depending on the pit and land lengths directly before and after detection by the pit/land length detection circuit. For example, if the directly previous land domain is longer, the time period L1 is longer, whereas, if the directly previous land domain is shorter, the time period L1 is shorter.

[0075] That is, the laser driving pattern is controlled depending on variations in the heat storage caused by different pit/land lengths.

[0076] The lengths of the time periods L1 and L2 are variable in a range from 0T to 3T.

[0077] Although not shown, the levels (voltage values) of the end over-drive pulse and the first over-drive pulse may be varied depending on the lengths of the fore and aft side pit and land, as in L1 and L2 above.

[0078] That is, the heat quantity stored in the disc 1 is determined on the basis of both the laser light volume and the time period, such that optimum laser drive pattern may be set depending on the variations of the heat storage quantity by the pit length/land length.

[0079] For example, the level Pod in Fig.16 is changed between e.g., a 20%-up value, 25%-up value and a 30%-up value of the recording laser power Pw.

[0080] So, when a CD-R as the disc 1 is run in rotation at an octupled speed for data recording, the parameters given in generating the respective pulses are hereinafter explained, taking a waveform pattern shown in Fig.19 as an example.

[0081] With the EQEFM signal having a pulse width of (N-0.25)T, the first over-drive pulse and the end over-drive pulse, added to the EQEFM signal, are of pulse widths L1 and L2 equal to 1.75T and 1T, respectively, if the length of the lands formed directly ahead and at back is 8T. These pulses are of a level (amplitude) larger by approximately 30% than the level of the EQEFM signal. Meanwhile, the pulse width of the first over-drive pulse is varied, as the system controller 9 sets parameters for the recording signal generator 121, depending on the length of the pit to be recorded (3T to 11T) or the length of the land (3T to 11T) formed directly before and after the pit. That is, there are a sum total of 729 parameters corresponding to different combinations of nine directly previous land lengths, nine recording pit lengths and nine directly following land lengths. For example, L1 = 1.75T is set to 1.05T and to 0.35T if the recording pit length is 4T and in a range of 5T to 11T, respectively. In addition, -0.2T to +0.2T is added to these values depending on the directly previous land lengths. For example, if L1 = 1.75T is a reference value, Li is set to a value from 1.55T to 1.95T.

[0082] In actuality, the pulse width and the pulse level are also adjusted depending on the type of the disc material (that of the dye film material), disc producer, recording linear speed, recording speed or characteristics of the optical system of the optical pickup 1.

[0083] Moreover, since the difference in the thermal reaction is caused by e.g., the difference in the type of the dye film material, it is effective to discriminate the sort of the disc loaded or the maker at the time of recording to adjust the pulse width or the pulse level. The execution environment during recording, such as the recording linear speed or the recording speed, may be transmitted by e.g., the system controller 9 to the recording pulse generator 121 to adjust the pulse width or the pulse level for optimal recording.

[0084] Thus, by controlling the laser light emission by the driving current i corresponding to the sum of the EQEFM signal to the end over-drive pulse and to the first over-drive pulse as shown in Fig.16A, by varying the level or the pulse width of the EQEFM signal, end over-drive pulse and the first over-drive pulse in the recording pulse generator 121 depending on recording conditions or on the lengths of fore and aft side pits and lands and by optionally variably setting the pulse width depending on different durations of 3T to 11T. The first embodiment of the present invention and the modified example may also be applied in combination.

Claims

1. An optical disc recording apparatus comprising:

   recording pulse generating means (5) for generating a recording pulse of a pulse width corresponding to a length of a pit to be formed; and
   laser means (3) for illuminating the laser light by the recording pulse supplied to form a recording data string comprised of pits and lands defined between said pits on a recording medium (1);

   characterized in that
   said recording pulse generating means (5) sets a recording power at the leading end portion of said recording pulse in steps of a plurality of stages, wherein
   said recording pulse generating means (5) generates at least a first pulse (EQEFM) corresponding to recording

data, a second pulse (ODP1) for synthesis to a leading end of said first pulse (EQEFM) and a third pulse (ODP2) for synthesis to a leading end of said second pulse (ODP1), said third pulse (ODP2) being of a pulse width smaller than said second pulse (ODP1), said first to third pulses (EQEFM, ODP1, ODP2) being synthesized to generate said recording pulse.

2. The optical disc recording apparatus according to claim 1, wherein
said laser means (3) illuminates the laser light emitting pulsed light by the recording pulse generated by said recording pulse generating means (5) on a write-once optical disc as said recording medium (1) to effect recording.

3. The optical disc recording apparatus according to claim 1 or 2, wherein
said recording pulse generating means (5) varies the pulse width and/or the pulse level of one or more of said first to third pulses (EQEFM, ODP1, ODP2), depending on recording conditions, to generate said recording pulse.

4. The optical disc recording apparatus according to anyone of claims 1 to 3, wherein
said recording pulse generating means (5) includes pit/land length detection means (51) for detecting the length of the pit/land to be formed and varies the pulse width and/or the pulse level of one or more of said first to third pulses (EQEFM, ODP1, ODP2), depending on the combinations of the lengths of the pits/lands to be formed, based on a detection output by said pit/land length detection means (51), to generate a recording pulse.

5. The optical disc recording apparatus according to anyone of claims 1 to 3, wherein
said recording pulse generating means (5) varies the pulse width and/or the pulse level of one or more of said first to third pulses (EQEFM, ODP1, ODP2), depending on conditions of an optical disc for recording, to generate the recording pulse of a pulse width.

6. The optical disc recording apparatus according to claim 4, wherein
said recording pulse generating means (5) variably sets the pulse width of one or more of said first to third pulses (EQEFM, ODP1, ODP2) responsive to at least one of the length of the pit formed directly previously and the length of the land formed directly previously.

7. The optical disc recording apparatus according to claim 4 wherein
said recording pulse generating means (5) varies the pulse width of said first pulse (EQEFM) depending on the length of a land formed directly ahead of a pit formed.

8. The optical disc recording apparatus according to claim 7, wherein
said recording pulse generating means (5) varies the pulse width of said first pulse (EQEFM) depending on the length of a pit formed.

9. The optical disc recording apparatus according to claim 7, wherein
said recording pulse generating means (5) varies the pulse width of said first pulse (EQEFM) depending on the length of a land formed directly at back of a pit formed.

10. The optical disc recording apparatus according to anyone of claims 1 to 9 further comprising:

changeover means (SW1, SW2, SW3) for switching the operation of said drive pulse generating means (5) to preclude outputting of at least one of said first to third pulses (EQEFM, ODP1, ODP2) generated by said recording pulse generating means (5), said recording pulse generating means (5) performing switching control of said changeover means (SW1, SW2, SW3) in association with a speed of forming a recording data string on said recording medium (1).

11. The optical disc recording apparatus according to claim 10 wherein
said recording pulse generating means (5) controls said changeover means (SW1, SW2, SW3) so that, if an optical disc is rotated at a linear speed not higher than a speed four times a reference speed, said third pulse (ODP2) is not output.

12. A recording method for an optical disc comprising:

generating (5) a recording pulse of a pulse width corresponding to a length of a pit to be formed; and
illuminating (3) the laser light by the recording pulse supplied to form a recording data string comprised of pits

and lands defined between said lands on a recording medium (1);

characterized in that
in said generating step (5) a recording power is set at the leading end portion of said recording pulse in steps of a plurality of stages, wherein
at least a first pulse (EQEFM) corresponding to recording data, a second pulse (ODP1) for synthesis to a leading end of said first pulse (EQEFM) and a third pulse (ODP2) for synthesis to a leading end of said second pulse (ODP1) are generated, said third pulse (ODP2) being of a pulse width smaller than said second pulse (ODP1), said first to third pulses (EQEFM, ODP1, ODP2) being synthesized to generate said recording pulse.

13. The recording method for an optical disc according to claim 12, wherein
the laser light emitting pulsed light by the recording pulse generated in said recording pulse generating step (5) is illuminated on a write-once optical disc as said recording medium (1) to effect recording.

14. The recording method for an optical disc according to claim 12 or 13, wherein
in said recording pulse generating step (5) the pulse width and/or the pulse level of one or more of said first to third pulses (EQEFM, ODP1, ODP2) is varied depending on recording conditions, to generate said recording pulse.

15. The recording method for an optical disc according to anyone of claims 12 to 14, wherein
the length of the pit/land to be formed is detected (51) and the pulse width and/or the pulse level of one or more of said first to third pulses (EQEFM, ODP1, ODP2) is varied, depending on the combinations of the lengths of the pits/lands to be formed, based on a detection output, to generate a recording pulse.

16. The recording method for an optical disc according to anyone of claims 12 to 14, wherein
the pulse width and/or the pulse level of one or more of said first to third pulses (EQEFM, ODP1, ODP2) is varied, depending on conditions of an optical disc for recording, to generate the recording pulse of a pulse width.

17. The recording method for an optical disc according to claim 15, wherein
the pulse width of one or more of said first to third pulses (EQEFM, ODP1, ODP2) is variably set responsive to at least one of the length of the pit formed directly previously and the length of the land formed directly previously.

18. The recording method for an optical disc according to claim 15, wherein
the pulse width of said first pulse (EQEFM) is varied depending on the length of a land formed directly ahead of a pit formed.

19. The recording method for an optical disc according to claim 18, wherein
the pulse width of said first pulse (EQEFM) is varied depending on the length of a pit formed.

20. The recording method for an optical disc according to claim 18, wherein
the pulse width of said first pulse (EQEFM) is varied depending on the length of a land formed directly at back of a pit formed.

21. The recording method for an optical disc according to anyone of claims 12 to 20 further comprising the step of:

controlling the output (SW1, SW2, SW3) of at least one of said first to third pulses (EQEFM, ODP1, ODP2) generated in said recording pulse generating step (5) in association with a speed of forming a recording data string on said recording medium (1).

22. The optical disc recording apparatus according to claim 21 wherein
if an optical disc is rotated at a linear speed not higher than a speed four times a reference speed, said third pulse (ODP2) is not output.

Patentansprüche

1. Aufzeichnungsvorrichtung für eine optische Platte umfassend:

eine Aufzeichnungspuls-Erzeugungseinrichtung (5) zum Erzeugen eines Aufzeichnungspulses mit einer Puls-

breite, die einer Länge einer zu bildenden Vertiefung entspricht; und
eine Lasereinrichtung (3) zum Abstrahlen von Laserlicht mit Hilfe des bereitgestellten Aufzeichnungspulses, um einen Aufzeichnungsdatenstrang zu bilden, der Vertiefungen und Erhebungen, die zwischen den Vertiefungen auf einem Aufzeichnungsmedium (1) definiert sind, aufweist;

dadurch gekennzeichnet,
dass die Aufzeichnungspuls-Erzeugungseinrichtung (5) eine Aufzeichnungsleistung an dem Vorderende des Aufzeichnungspulses in Schritten von mehreren Stufen einstellt, wobei die Aufzeichnungspuls-Erzeugungseinrichtung (5) mindestens einen ersten Puls (EQEFM), der den Aufzeichnungsdaten entspricht, einen zweiten Puls (ODP1) zum Verbinden mit einem Vorderende des ersten Pulses (EQEFM) und einen dritten Puls (ODP2) zum Verbinden mit einem Vorderende des zweiten Pulses (ODP1) erzeugt, wobei der dritte Puls (ODP2) eine Pulsbreite aufweist, die kleiner ist als die des zweiten Pulses (ODP1), wobei der erste bis dritte Puls (EQEFM, ODP1, ODP2) zusammengesetzt werden, um den Aufzeichnungspuls zu erzeugen.

2. Aufzeichnungsvorrichtung für eine optische Platte nach Anspruch 1, wobei die Lasereinrichtung (3) zum Abstrahlen des Laserlichts durch den Aufzeichnungspuls, der durch die Aufzeichnungspuls-Erzeugungseinrichtung (5) erzeugt wird, gepulstes Licht auf eine einmal beschreibbare optische Platte als das Aufzeichnungsmedium (1) abstrahlt, um das Aufzeichnen zu bewirken.

3. Aufzeichnungsvorrichtung für eine optische Platte nach Anspruch 1 oder 2, wobei die Aufzeichnungspuls-Erzeugungseinrichtung (5) die Pulsbreiten und/oder die Pulshöhen eines oder mehrerer des ersten bis dritten Pulses (EQEFM, ODP1, ODP2) abhängig von den Aufzeichnungsbedingungen variiert, um den Aufzeichnungspuls zu erzeugen.

4. Aufzeichnungsvorrichtung für eine optische Platte nach einem der Ansprüche 1 bis 3, wobei die Aufzeichnungspuls-Erzeugungseinrichtung (5) eine Vertiefung-/Erhebungslängen-Detektionseinrichtung (51) umfasst, um die Länge der zu bildenden Vertiefung/Erhebung zu detektieren, und die Pulsbreiten und/oder die Pulshöhen eines oder mehreren des ersten bis dritten Pulses (EQEFM, ODP1, ODP2) abhängig von den Kombinationen der Längen der zu bildenden Vertiefungen/Erhebungen anhand einer Detektionsausgabe, die durch die Vertiefungs-/Erhebungslängen-Detektionseinrichtung (51) ausgegeben wird, variiert, um den Aufzeichnungspuls zu erzeugen.

5. Aufzeichnungsvorrichtung für eine optische Platte nach einem der Ansprüche 1 bis 3, wobei die Aufzeichnungspuls-Erzeugungseinrichtung (5) die Pulsbreiten und/oder die Pulshöhen eines oder mehrerer des ersten bis dritten Pulses (EQEFM, ODP1, ODP2) abhängig Zuständen einer zum Aufzeichnen vorgesehenen optischen Platte variiert, um den Aufzeichnungspuls mit einer Pulsbreite zu erzeugen.

6. Aufzeichnungsvorrichtung für eine optische Platte nach Anspruch 4, wobei die Aufzeichnungspuls-Erzeugungseinrichtung (5) die Pulsbreiten eines oder mehreren des ersten bis dritten Pulses (EQEFM, ODP1, ODP2) als Antwort auf die Länge der unmittelbar zuvor gebildeten Vertiefung und/oder auf die Länge der unmittelbar zuvor gebildeten Erhebung variabel einstellen.

7. Aufzeichnungsvorrichtung für eine optische Platte nach Anspruch 4, wobei die Aufzeichnungspuls-Erzeugungseinrichtung (5) die Pulsbreite des ersten Pulses (EQEFM) abhängig von der Länge einer Erhebung, die unmittelbar vor einer gebildeten Vertiefung ausgebildet ist, variiert.

8. Aufzeichnungsvorrichtung für eine optische Platte nach Anspruch 7, wobei die Aufzeichnungspuls-Erzeugungseinrichtung (5) die Pulsbreite des ersten Pulses (EQEFM) abhängig von der Länge einer gebildeten Vertiefung variiert.

9. Aufzeichnungsvorrichtung für eine optische Platte nach Anspruch 7, wobei die Aufzeichnungspuls-Erzeugungseinrichtung (5) die Pulsbreite des ersten Pulses (EQEFM) abhängig von der Länge einer Erhebung, die unmittelbar hinter einer gebildeten Vertiefung ausgebildet ist, variiert.

10. Aufzeichnungsvorrichtung für eine optische Platte nach einem der Ansprüche 1 bis 9, die weiterhin umfasst:

eine Umschalteinrichtung (SW1, SW2, SW3) zum Umschalten des Betriebs der Treiberpuls-Erzeugungseinrichtung (5), um die Ausgabe von mindestens einem des ersten bis dritten Pulses (EQEFM, ODP1, ODP2), die durch die Aufzeichnungspuls-Erzeugungseinrichtung (5) erzeugt werden, zu verhindern, wobei die Aufzeichnungspuls-Erzeugungseinrichtung (5) ein Steuern des Umschaltens der Umschalteinrichtung (SW1, SW2, SW3)

in Verbindung mit einer Geschwindigkeit des Ausbildens eines Aufzeichnungsdatenstranges auf dem Aufzeichnungsmedium (1) durchführt.

11. Aufzeichnungsvorrichtung für eine optische Platte nach Anspruch 10, wobei die Aufzeichnungspuls-Erzeugungseinrichtung (5) die Umschalteinrichtung (SW1, SW2, SW3) so steuert, dass, wenn sich eine optische Platte mit einer linearen Geschwindigkeit dreht, die nicht größer ist als eine vierfache Geschwindigkeit einer Referenzgeschwindigkeit, der dritte Puls (ODP2) nicht ausgegeben wird.

12. Aufzeichnungsverfahren für eine optische Platte umfassend:

Erzeugen (5) eines Aufzeichnungspulses mit einer Pulsbreite, die einer Länge einer zu bildenden Vertiefung entspricht; und
Bestrahlen (3) mit Laserlicht durch den bereitgestellten Aufzeichnungspuls, um einen Aufzeichnungsdatenstrang auszubilden, der Vertiefungen und Erhebungen, die zwischen den Vertiefungen auf einem Aufzeichnungsmedium (1) definiert sind, aufweist;

dadurch gekennzeichnet,
dass in dem Schritt des Erzeugens eine Aufzeichnungsleistung an dem Vorderende des Aufzeichnungspulses in Schritten von mehreren Stufen eingestellt wird, wobei mindestens ein erster Puls (EQEFM), der den Aufzeichnungsdaten entspricht, ein zweiter Puls (ODP1) zum Verbinden mit einem Vorderende des ersten Pulses (EQEFM) und ein dritter Puls (ODP2) zum Verbinden mit dem Vorderende des zweiten Pulses (ODP1) erzeugt werden, wobei der dritte Puls (ODP2) eine Pulsbreite aufweist, die kleiner ist als die des zweiten Pulses (ODP1), wobei der erste bis dritte Puls (EQEFM, ODP1, ODP2) zusammengesetzt werden, um den Aufzeichnungspuls zu erzeugen.

13. Aufzeichnungsverfahren für eine optische Platte gemäß Anspruch 12, wobei das Laserlicht als gepulstes Licht mit Hilfe des Aufzeichnungspulses, der in dem Schritt des Erzeugens des Aufzeichnungspulses (5) erzeugt wird, auf eine einmal beschreibbare optische Platte als das Aufzeichnungsmedium (1) abgestrahlt wird, um das Aufzeichnen zu bewirken.

14. Aufzeichnungsverfahren für eine optische Platte gemäß Anspruch 12 oder 13, wobei in dem Schritt des Erzeugens des Aufzeichnungspulses (5) die Pulsbreiten und/oder die Pulshöhen eines oder mehrerer des ersten bis dritten Pulses (EQEFM, ODP1, ODP2) abhängig von den Aufzeichnungszuständen variiert werden, um den Aufzeichnungspuls zu erzeugen.

15. Aufzeichnungsverfahren für eine optische Platte gemäß einem der Ansprüche 12 bis 14, wobei die Länge der zu bildenden Vertiefungen/Erhebungen detektiert wird (51) und die Pulsbreiten und/oder die Pulshöhen eines oder mehrerer des ersten bis dritten Pulses (EQEFM, ODP1, ODP2) abhängig von den Kombinationen der Längen der auszubildenden Vertiefungen/Erhebungen anhand der Detektionsausgabe variiert werden, um einen Aufzeichnungspuls zu erzeugen.

16. Aufzeichnungsverfahren für eine optische Platte gemäß einem der Ansprüche 12 bis 14, wobei die Pulsbreiten und/oder die Pulshöhen eines oder mehrerer des ersten bis dritten Pulses (EQEFM, ODP1, ODP2) abhängig von den Zuständen einer zum Aufzeichnen vorgesehenen optischen Platte variiert werden, um den Aufzeichnungspuls mit einer Pulsbreite zu erzeugen.

17. Aufzeichnungsverfahren für eine optische Platte gemäß Anspruch 15, wobei die Pulsbreiten eines oder mehrerer des ersten bis dritten Pulses (EQEFM, ODP1, ODP2) abhängig von der Länge der unmittelbar zuvor gebildeten Vertiefung und/oder der Länge der unmittelbar zuvor gebildeten Erhebung variabel eingestellt werden.

18. Aufzeichnungsverfahren für eine optische Platte gemäß Anspruch 15, wobei die Pulsbreite des ersten Pulses (EQEFM) abhängig von der Länge einer unmittelbar vor einer ausgebildeten Vertiefung gebildeten Erhebung variiert wird.

19. Aufzeichnungsverfahren für eine optische Platte gemäß Anspruch 18, wobei die Pulsbreite des ersten Pulses (EQEFM) abhängig von der Länge einer ausgebildeten Vertiefung variiert wird.

20. Aufzeichnungsverfahren für eine optische Platte gemäß Anspruch 18, wobei die Pulsbreite des ersten Pulses (EQEFM) abhängig von der Länge einer Erhebung, die unmittelbar hinter einer ausgebildeten Vertiefung gebildet

ist, variiert wird.

21. Aufzeichnungsverfahren für eine optische Platte gemäß einem der Ansprüche 12 bis 20, das weiterhin den Schritt umfasst:

Steuern des Ausgebens (SW1, SW2, SW3) mindestens eines des ersten bis dritten Pulses (EQEFM, ODP1, ODP2), die in dem Schritt des Erzeugens des Aufzeichnungspulses (5) in Verbindung mit einer Geschwindigkeit des Ausbildens eines Aufzeichnungsdatenstranges auf dem Aufzeichnungsmedium (1) erzeugt werden.

22. Aufzeichnungsverfahren für eine optische Platte gemäß Anspruch 21, wobei, wenn sich eine optische Platte mit einer linearen Geschwindigkeit dreht, die nicht höher ist als eine vierfache Geschwindigkeit einer Referenzgeschwindigkeit, der dritte Puls (ODP2) nicht ausgegeben wird.

Revendications

1. Appareil d'enregistrement de disque optique comprenant :

des moyens de génération d'impulsions d'enregistrement (5) pour générer une impulsion d'enregistrement d'une largeur d'impulsion correspondant à une longueur d'un creux à former ; et
des moyens à laser (3) pour illuminer la lumière laser par l'impulsion d'enregistrement délivrée pour former une chaîne de données d'enregistrement composée de creux et de plats définis entre lesdits creux sur un support d'enregistrement (1) ;
caractérisé en ce que
lesdits moyens de génération d'impulsions d'enregistrement (5) établissent une puissance d'enregistrement au niveau de la portion d'extrémité avant de ladite impulsion d'enregistrement dans des étapes d'une pluralité de phases, dans lequel
lesdits moyens de génération d'impulsions d'enregistrement (5) génèrent au moins une première impulsion (EQEFM) correspondant aux données d'enregistrement, une deuxième impulsion (ODP1) pour la synthèse à une extrémité avant de ladite première impulsion (EQEFM) et une troisième impulsion (ODP2) pour la synthèse à une extrémité avant de ladite deuxième impulsion (ODP1), ladite troisième impulsion (ODP2) étant d'une largeur d'impulsion plus petite que ladite deuxième impulsion (ODP1), lesdites première à troisième impulsions (EQEFM, ODP1, ODP2) étant synthétisées pour générer ladite impulsion d'enregistrement.

2. Appareil d'enregistrement de disque optique selon la revendication 1, dans lequel
lesdits moyens à laser (3) illuminent la lumière laser émettant une lumière pulsée par l'impulsion d'enregistrement générée par lesdits moyens de génération d'impulsions d'enregistrement (5) sur un disque optique à écriture unique comme ledit support d'enregistrement (1) pour effectuer l'enregistrement.

3. Appareil d'enregistrement de disque optique selon la revendication 1 ou 2, dans lequel
lesdits moyens de génération d'impulsions d'enregistrement (5) font varier la largeur d'impulsion et/ou le niveau d'impulsion d'une ou plusieurs desdites première à troisième impulsions (EQEFM, ODP1, ODP2), en fonction des conditions d'enregistrement, pour générer ladite impulsion d'enregistrement.

4. Appareil d'enregistrement de disque optique selon l'une quelconque des revendications 1 à 3, dans lequel
lesdits moyens de génération d'impulsions d'enregistrement (5) comprennent des moyens de détection de longueur de creux/plat (51) pour détecter la longueur du creux/plat à former et font varier la largeur d'impulsion et/ou le niveau d'impulsion d'une ou plusieurs desdites première à troisième impulsions (EQEFM, ODP1, ODP2), en fonction des combinaisons des longueurs de creux/plats à former, sur la base d'un résultat de détection par lesdits moyens de détection de longueur de creux/plat (51), pour générer ladite impulsion d'enregistrement.

5. Appareil d'enregistrement de disque optique selon l'une quelconque des revendications 1 à 3, dans lequel
lesdits moyens de génération d'impulsions d'enregistrement (5) font varier la largeur d'impulsion et/ou le niveau d'impulsion d'une ou plusieurs desdites première à troisième impulsions (EQEFM, ODP1, ODP2), en fonction des conditions d'un disque optique pour l'enregistrement, pour générer la impulsion d'enregistrement d'une largeur d'impulsion.

6. Appareil d'enregistrement de disque optique selon la revendication 4, dans lequel

lesdits moyens de génération d'impulsions d'enregistrement (5) fixent de manière variable la largeur d'impulsion d'une ou plusieurs desdites première à troisième impulsions (EQEFM, ODP1, ODP2) en réponse à au moins une parmi la longueur du creux formé directement précédemment et la longueur du plat formé directement précédemment.

7. Appareil d'enregistrement de disque optique selon la revendication 4, dans lequel
lesdits moyens de génération d'impulsions d'enregistrement (5) font varier la largeur d'impulsion de ladite première impulsion (EQEFM), en fonction de la longueur d'un plat formé directement avant un creux formé.

8. Appareil d'enregistrement de disque optique selon la revendication 7, dans lequel
lesdits moyens de génération d'impulsions d'enregistrement (5) font varier la largeur d'impulsion de ladite première impulsion (EQEFM), en fonction de la longueur d'un creux formé.

9. Appareil d'enregistrement de disque optique selon la revendication 7, dans lequel
lesdits moyens de génération d'impulsions d'enregistrement (5) font varier la largeur d'impulsion de ladite première impulsion (EQEFM), en fonction de la longueur d'un plat formé directement après un creux formé.

10. Appareil d'enregistrement de disque optique selon l'une quelconque des revendications 1 à 9, comprenant :

des moyens de commutation (SW1, SW2, SW3) pour commuter le fonctionnement desdits moyens de génération d'impulsions d'enregistrement (5) pour exclure la sortie d'au moins une desdites première à troisième impulsions (EQEFM, ODP1, ODP2) générées par lesdits moyens de génération d'impulsions d'enregistrement (5), lesdits moyens de génération d'impulsions d'enregistrement (5) effectuant la commande de commutation desdits moyens de commutation (SW1, SW2, SW3) en association avec une vitesse de formation d'une chaîne de données d'enregistrement sur ledit support d'enregistrement (1).

11. Appareil d'enregistrement de disque optique selon la revendication 10, dans lequel
lesdits moyens de génération d'impulsions d'enregistrement (5) commandent lesdits moyens de commutation (SW1, SW2, SW3) de manière que, si un disque optique est entraîné en rotation à une vitesse linéaire non supérieure à une vitesse quadruple d'une vitesse de référence, ladite troisième impulsion (ODP2) n'est pas délivrée en sortie.

12. Procédé d'enregistrement pour un disque optique consistant à :

générer (5) une impulsion d'enregistrement d'une largeur d'impulsion correspondant à une longueur d'un creux à former ; et
illuminer (3) la lumière laser par l'impulsion d'enregistrement pour former une chaîne de données d'enregistrement constitué de creux et de plats définis entre lesdits creux sur un support d'enregistrement (1) ;
caractérisé en ce que
dans ladite étape (5), une puissance d'enregistrement est établie au niveau de la portion d'extrémité avant de ladite impulsion d'enregistrement dans des étapes d'une pluralité de phases, dans lequel
au moins une première impulsion (EQEFM) correspondant aux données d'enregistrement, une deuxième impulsion (ODP1) pour la synthèse à une extrémité avant de ladite première impulsion (EQEFM) et une troisième impulsion (ODP2) pour la synthèse à une extrémité avant de ladite deuxième impulsion (ODP1) sont générées, ladite troisième impulsion (ODP2) étant d'une largeur d'impulsion plus petite que ladite deuxième impulsion (ODP1), lesdites première à troisième impulsions (EQEFM, ODP1, ODP2) étant synthétisées pour générer ladite impulsion d'enregistrement.

13. Procédé d'enregistrement pour un disque optique selon la revendication 12, dans lequel
la lumière laser émettant une lumière pulsée par l'impulsion d'enregistrement générée dans ladite étape de génération d'impulsions d'enregistrement (5) est illuminée sur un disque optique à écriture unique comme ledit support d'enregistrement (1) pour effectuer l'enregistrement.

14. Procédé d'enregistrement pour un disque optique selon la revendication 12 ou 13, dans lequel
dans ladite étape de génération d'impulsions d'enregistrement (5), la largeur d'impulsion et/ou le niveau d'impulsion d'une ou plusieurs desdites première à troisième impulsions (EQEFM, ODP1, ODP2) est modifié en fonction des conditions d'enregistrement, pour générer ladite impulsion d'enregistrement.

15. Procédé d'enregistrement pour un disque optique selon l'une quelconque des revendications 12 à 14, dans lequel

la longueur du creux/plat à former est détectée (51) et la largeur d'impulsion et/ou le niveau d'impulsion d'une ou plusieurs desdites première à troisième impulsions (EQEFM, ODP1, ODP2) est modifié en fonction des combinaisons des longueurs de creux/plats à former, sur la base d'un résultat de détection, pour générer ladite impulsion d'enregistrement.

16. Procédé d'enregistrement pour un disque optique selon l'une quelconque des revendications 12 à 14, dans lequel la largeur d'impulsion et/ou le niveau d'impulsion d'une ou plusieurs desdites première à troisième impulsions (EQEFM, ODP1, ODP2) est modifié, en fonction des conditions d'un disque optique pour l'enregistrement, pour générer la impulsion d'enregistrement d'une largeur d'impulsion.

17. Procédé d'enregistrement pour un disque optique selon la revendication 15, dans lequel
la largeur d'impulsion d'une ou plusieurs desdites première à troisième impulsions (EQEFM, ODP1, ODP2) est fixée de manière variable en réponse à au moins une parmi la longueur du creux formé directement précédemment et la longueur du plat formé directement précédemment.

18. Procédé d'enregistrement pour un disque optique selon la revendication 15, dans lequel
la largeur d'impulsion de ladite première impulsion (EQEFM) est modifiée en fonction de la longueur d'un plat formé directement avant un creux formé.

19. Procédé d'enregistrement pour un disque optique selon la revendication 18, dans lequel
la largeur d'impulsion de ladite première impulsion (EQEFM) est modifiée en fonction de la longueur d'un creux formé.

20. Procédé d'enregistrement pour un disque optique selon la revendication 18, dans lequel
la largeur d'impulsion de ladite première impulsion (EQEFM) est modifiée en fonction de la longueur d'un plat formé directement après un creux formé.

21. Procédé d'enregistrement pour un disque optique selon l'une quelconque des revendications 12 à 20, comprenant en outre l'étape consistant à :

Commander la sortie (SW1, SW2, SW3) d'au moins une desdites première à troisième impulsions (EQEFM, ODP1, ODP2) générées par lesdits moyens de génération d'impulsions d'enregistrement (5) en association avec une vitesse de formation d'une chaîne de données d'enregistrement sur ledit support d'enregistrement (1).

22. Procédé d'enregistrement pour un disque optique selon la revendication 21, dans lequel
si un disque optique est entraîné en rotation à une vitesse linéaire non supérieure à une vitesse quadruple d'une vitesse de référence, ladite troisième impulsion (ODP2) n'est pas délivrée en sortie.

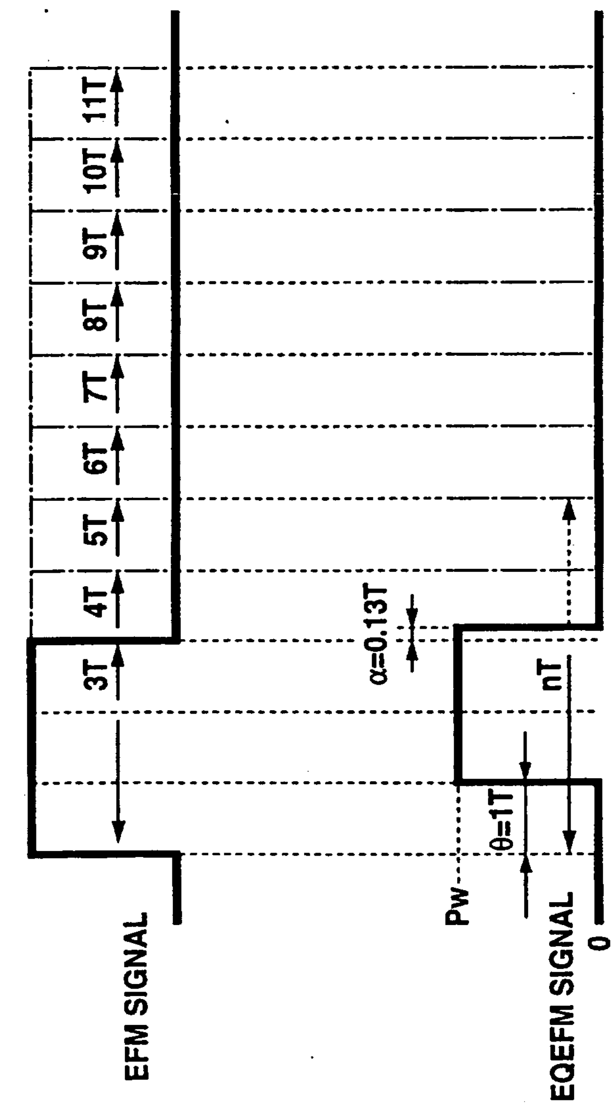

EFM SIGNAL
3T
4T
5T
6T
7T
8T
9T
10T
11T
EQEFM SIGNAL
Pw
0
θ=1T
α=0.13T
nT

FIG.1A

FIG.1B

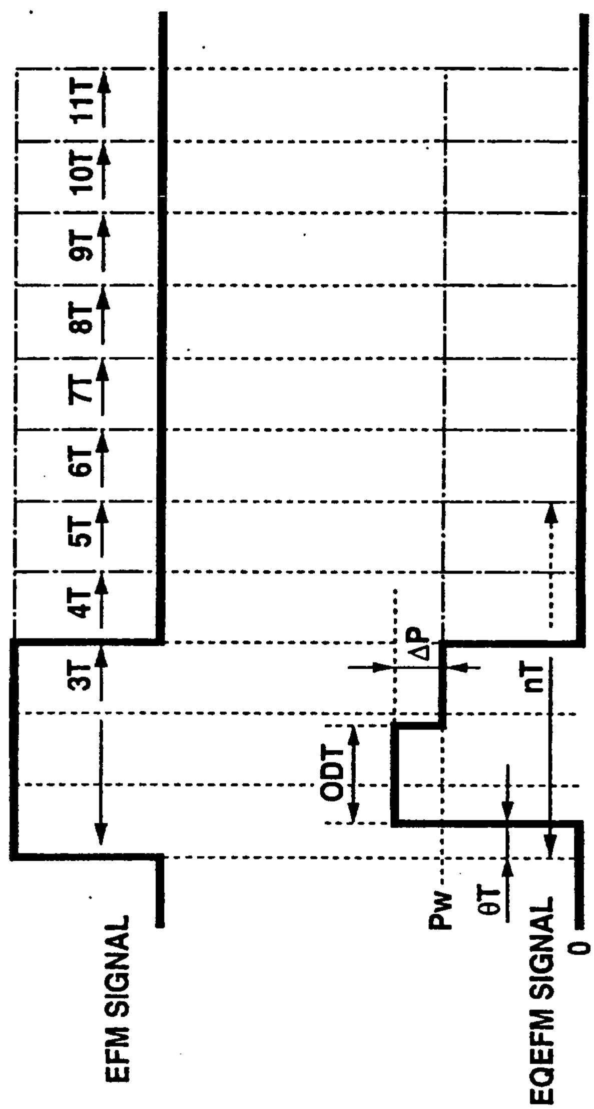

EFM SIGNAL
3T
4T
5T
6T
7T
8T
9T
10T
11T
ODT
ΔP
Pw
θT
nT
EQEFM SIGNAL
0

FIG.2A

FIG.2B

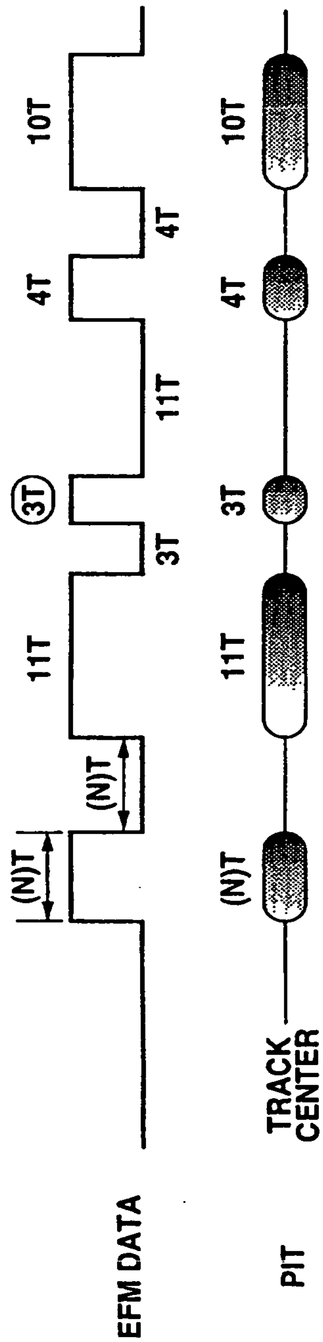

EFM DATA
(N)T
(N)T
11T
3T
3T
11T
4T
4T
10T
PIT
TRACK CENTER
(N)T
11T
3T
4T
10T

FIG.3A

FIG.3B

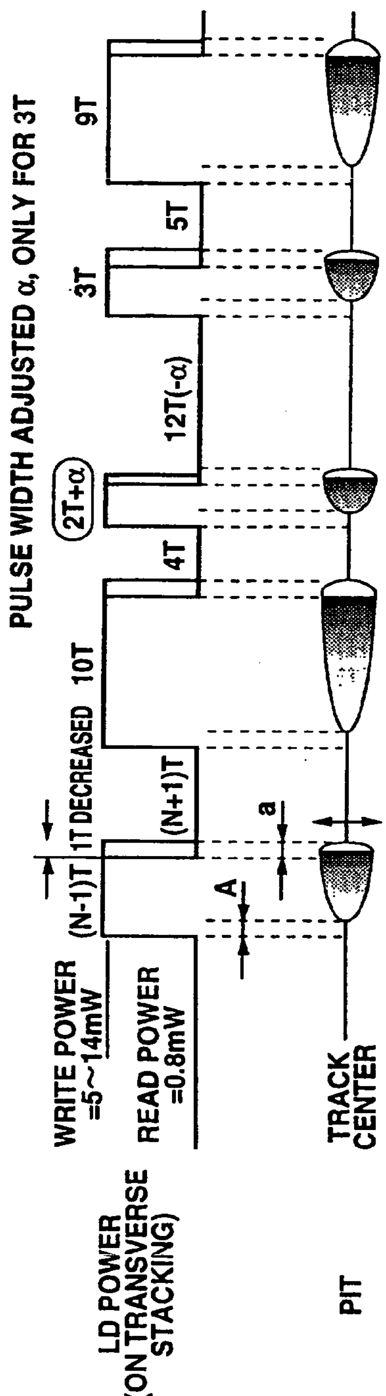

PULSE WIDTH ADJUSTED α, ONLY FOR 3T
LD POWER (ON TRANSVERSE STACKING)
WRITE POWER =5~14mW
READ POWER =0.8mW
(N-1)T
1T DECREASED
(N+1)T
10T
4T
2T+α
12T(-α)
3T
5T
9T
A
a
PIT
TRACK CENTER

FIG.4A

FIG.4B

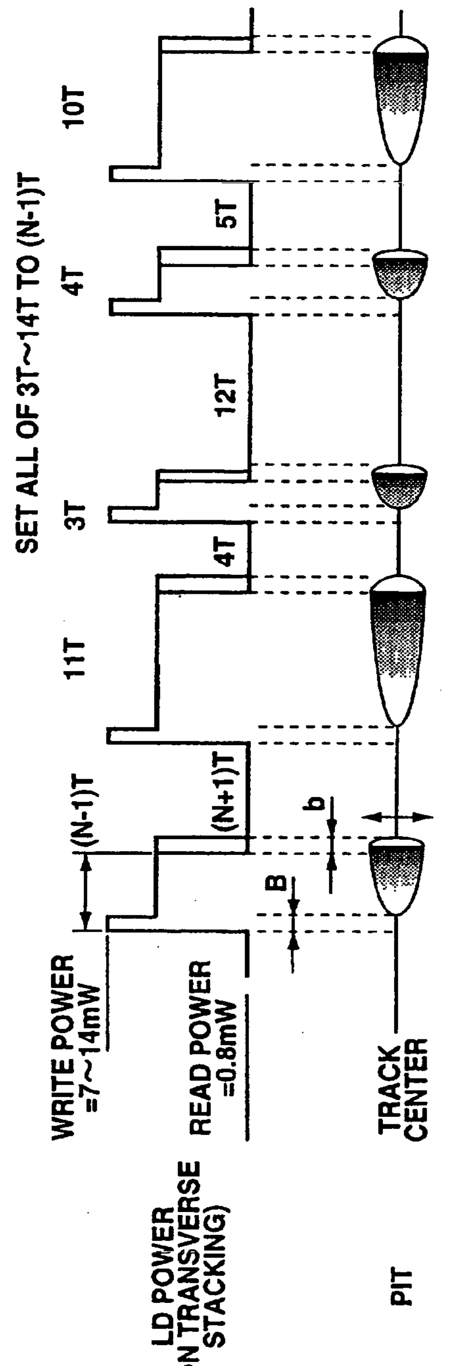

SET ALL OF 3T~14T TO (N-1)T
10T
4T
5T
12T
3T
4T
11T
(N-1)T
(N+1)T
b
B
WRITE POWER
=7~14mW
READ POWER
=0.8mW
TRACK
CENTER
LD POWER
(ON TRANSVERSE
STACKING)
PIT

FIG.5A

FIG.5B

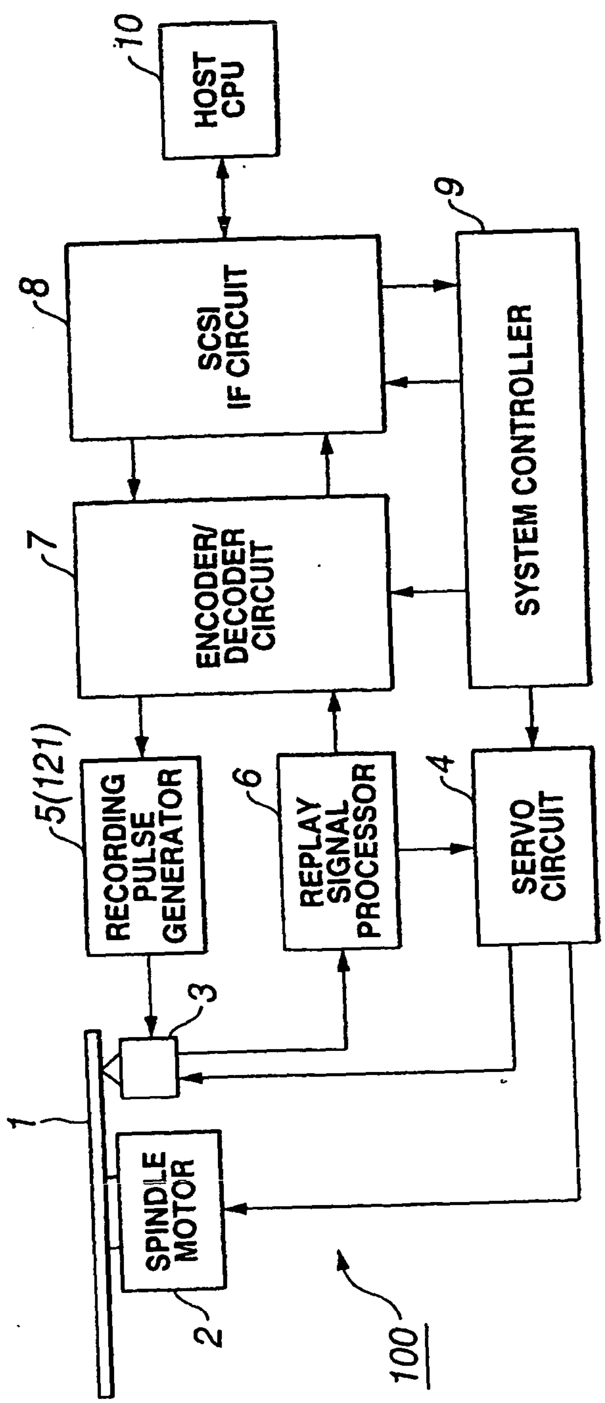

HOST CPU
10
SCSI IF CIRCUIT
8
SYSTEM CONTROLLER
9
ENCODER/ DECODER CIRCUIT
7
RECORDING PULSE GENERATOR
5(121)
REPLAY SIGNAL PROCESSOR
6
SERVO CIRCUIT
4
3
1
SPINDLE MOTOR
2
100

FIG.6

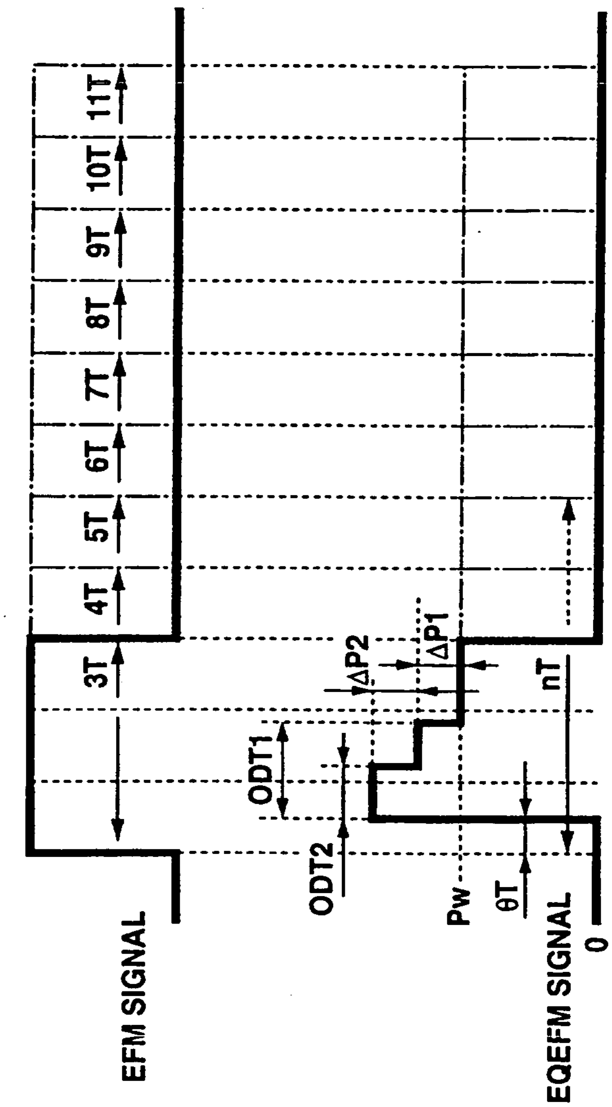
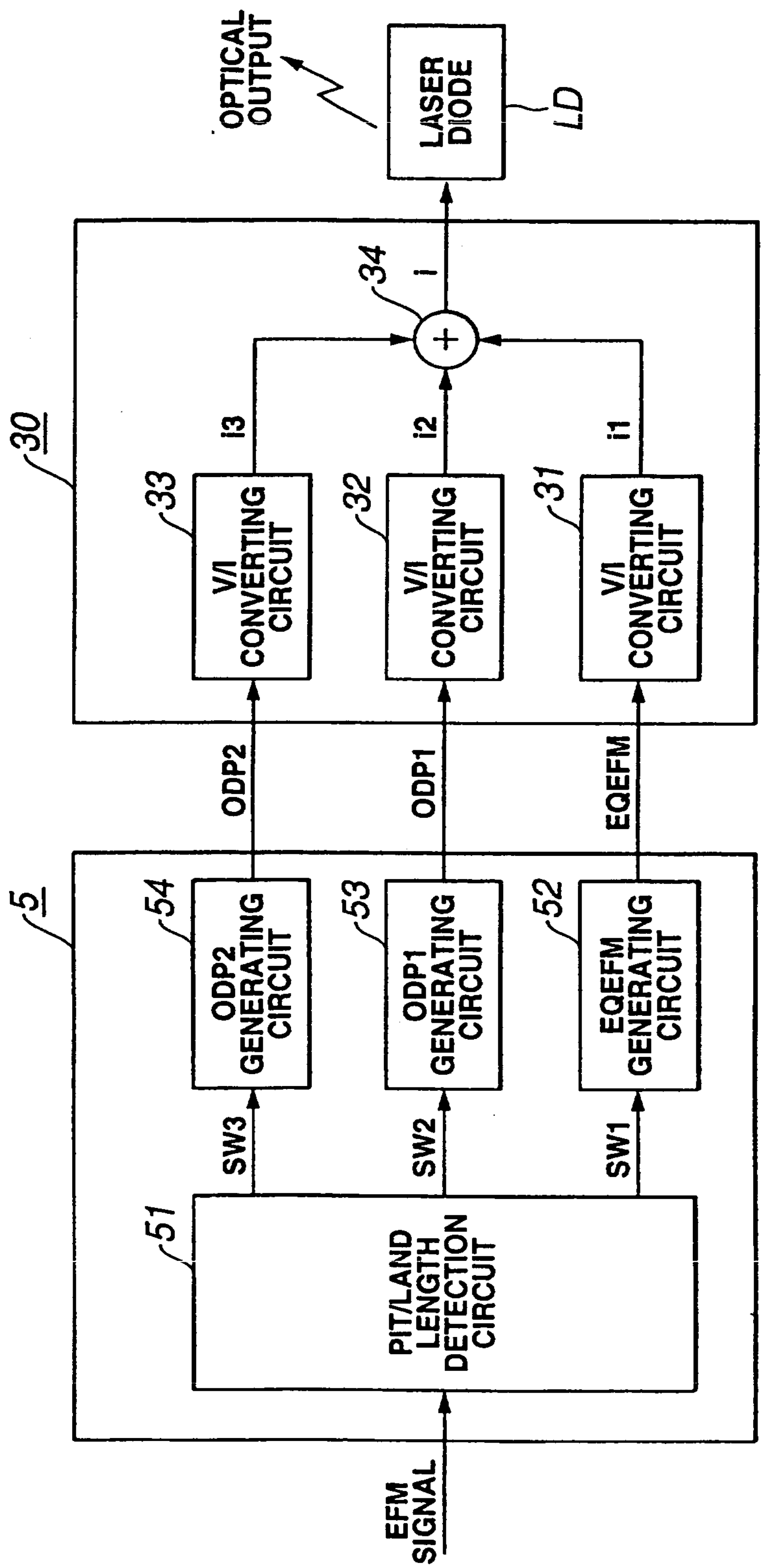

EFM SIGNAL
3T
4T
5T
6T
7T
8T
9T
10T
11T
ODT1
ODT2
ΔP2
ΔP1
Pw
θT
nT
EQEFM SIGNAL
0

FIG.7



EFM SIGNAL
5
51
PIT/LAND LENGTH DETECTION CIRCUIT
SW1
SW2
SW3
52
EQEFM GENERATING CIRCUIT
53
ODP1 GENERATING CIRCUIT
54
ODP2 GENERATING CIRCUIT
EQEFM
ODP1
ODP2
30
31
V/I CONVERTING CIRCUIT
32
V/I CONVERTING CIRCUIT
33
V/I CONVERTING CIRCUIT
i1
i2
i3
34
i
LASER DIODE
LD
OPTICAL OUTPUT

FIG.8

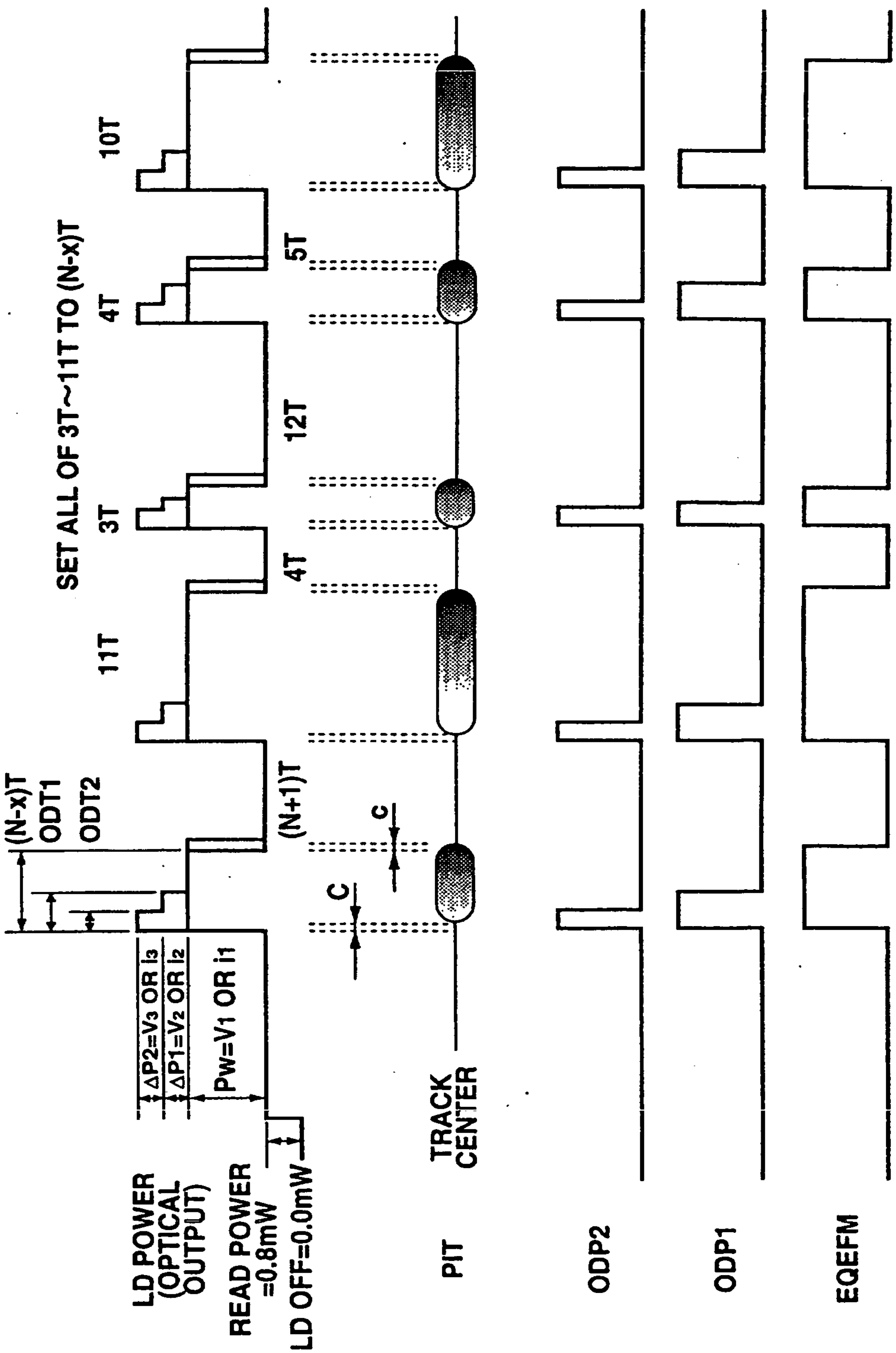

SET ALL OF 3T~11T TO (N-x)T
LD POWER (OPTICAL OUTPUT)
READ POWER =0.8mW
LD OFF=0.0mW
ΔP2=V3 OR I3
ΔP1=V2 OR I2
Pw=V1 OR I1
(N-x)T
ODT1
ODT2
(N+1)T
C
C
11T
4T
3T
12T
4T
5T
10T
TRACK CENTER
PIT
ODP2
ODP1
EQEFM

FIG.9

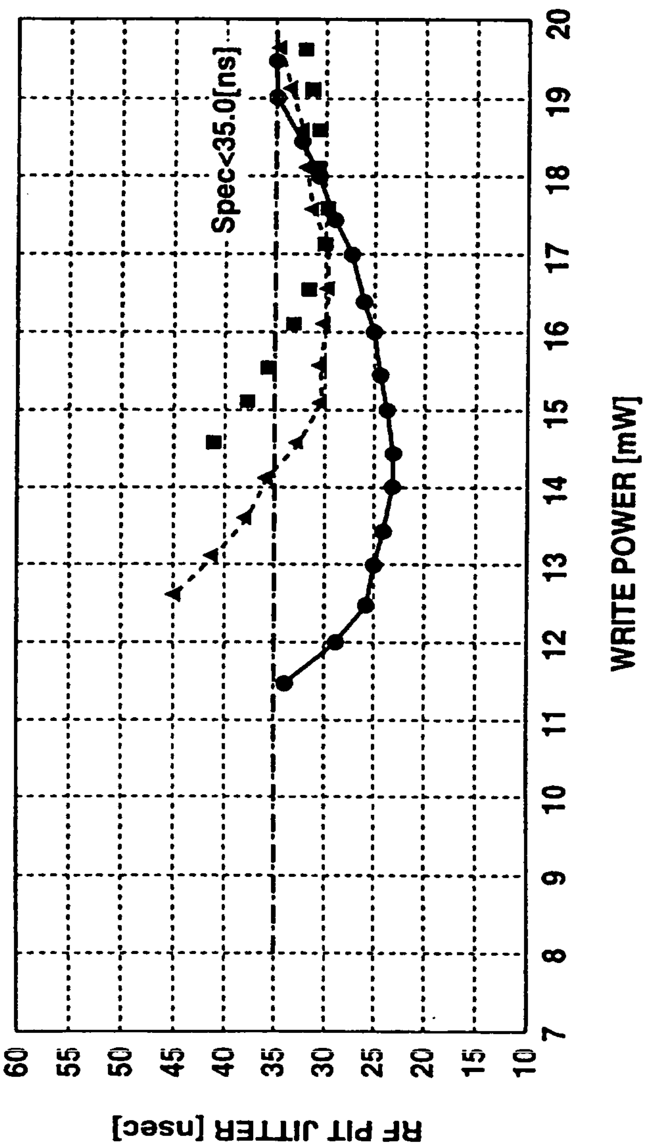

RF PIT JITTER [nsec]
60
55
50
45
40
35
30
25
20
15
10
WRITE POWER [mW]
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Spec<35.0[ns]

FIG.10

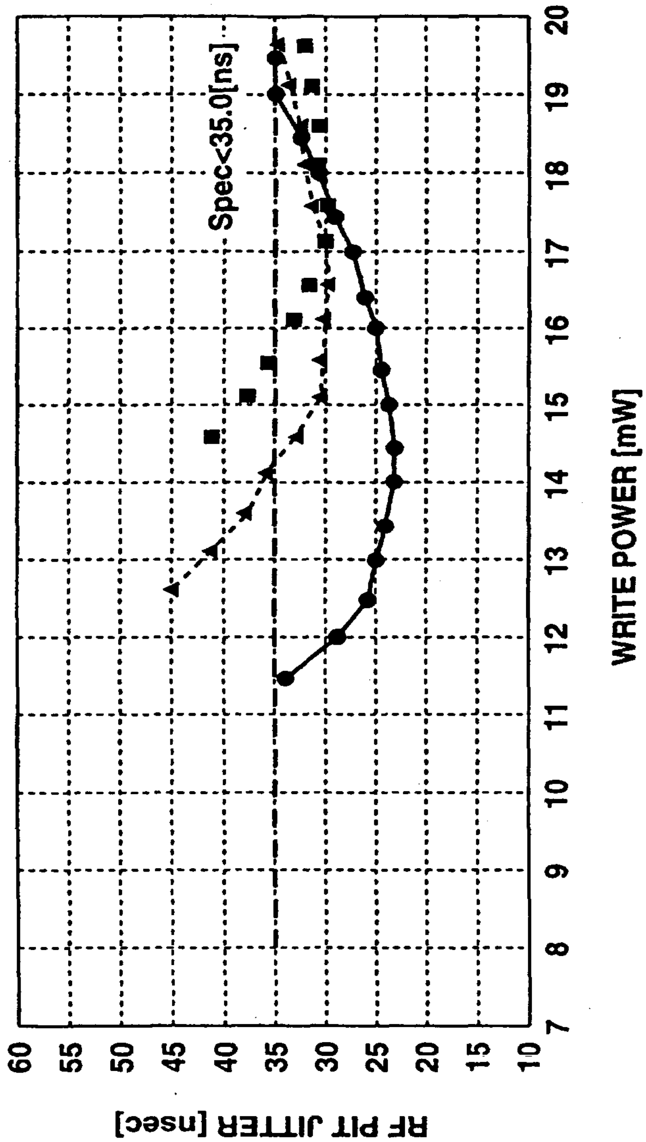

RF PIT JITTER [nsec]
60
55
50
45
40
35
30
25
20
15
10
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Spec<35.0[ns]
WRITE POWER [mW]

FIG.11

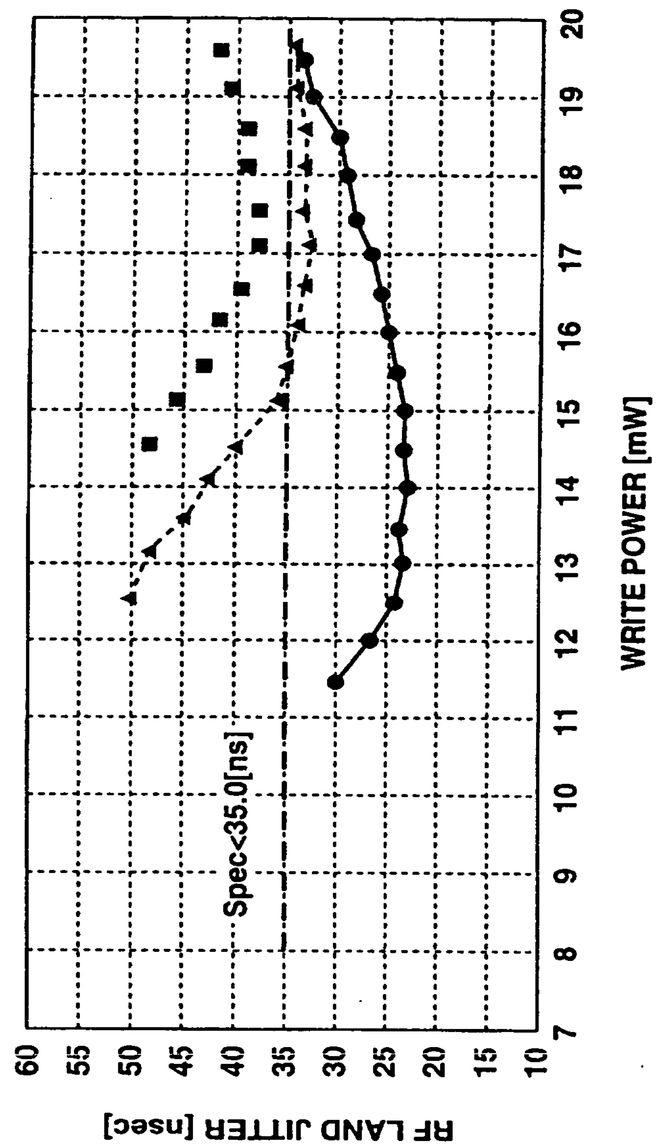

RF LAND JITTER [nsec]
60
55
50
45
40
35
30
25
20
15
10
7
8
9
10
11
12
13
14
15
16
17
18
19
20
WRITE POWER [mW]
Spec<35.0[ns]

FIG.12

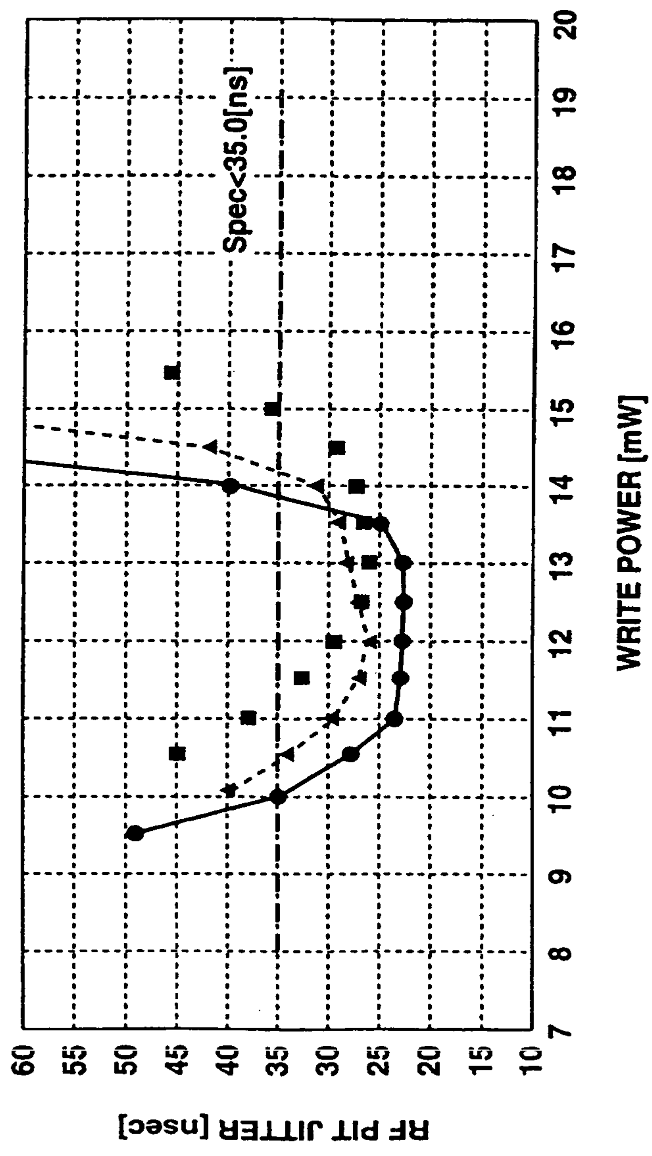

RF PIT JITTER [nsec]
WRITE POWER [mW]
Spec<35.0[ns]
60 55 50 45 40 35 30 25 20 15 10
7 8 9 10 11 12 13 14 15 16 17 18 19 20

FIG.13

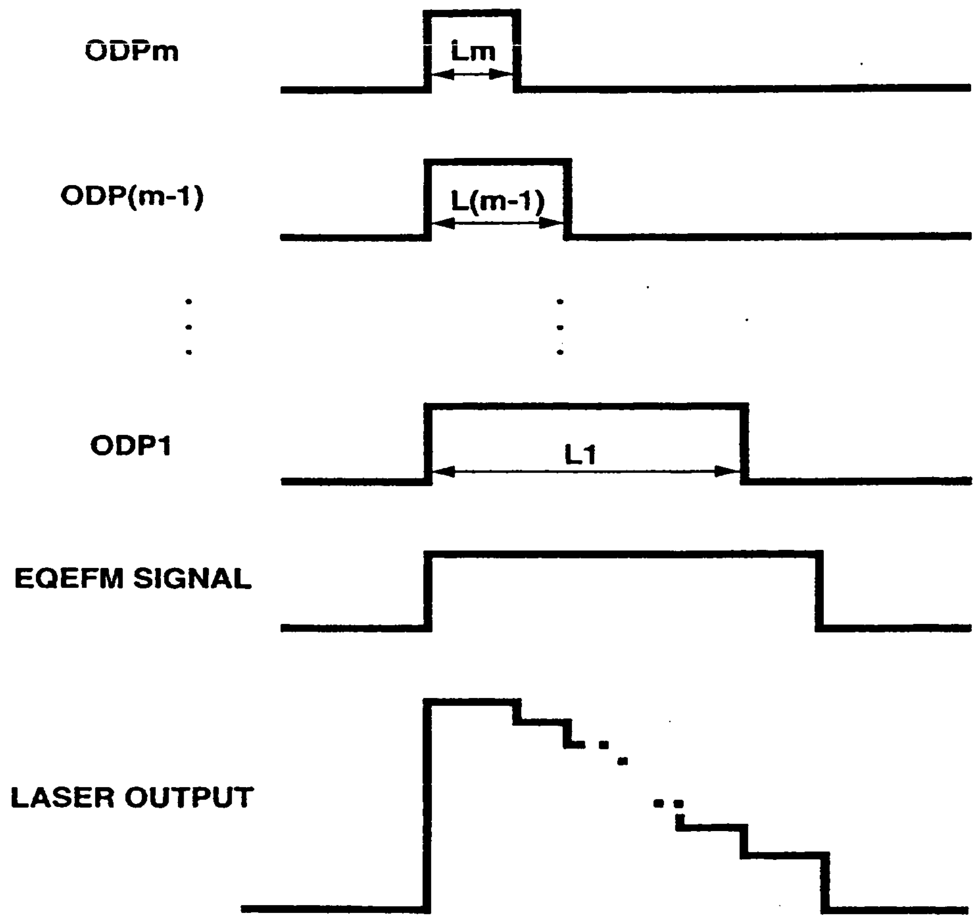


FIG.14

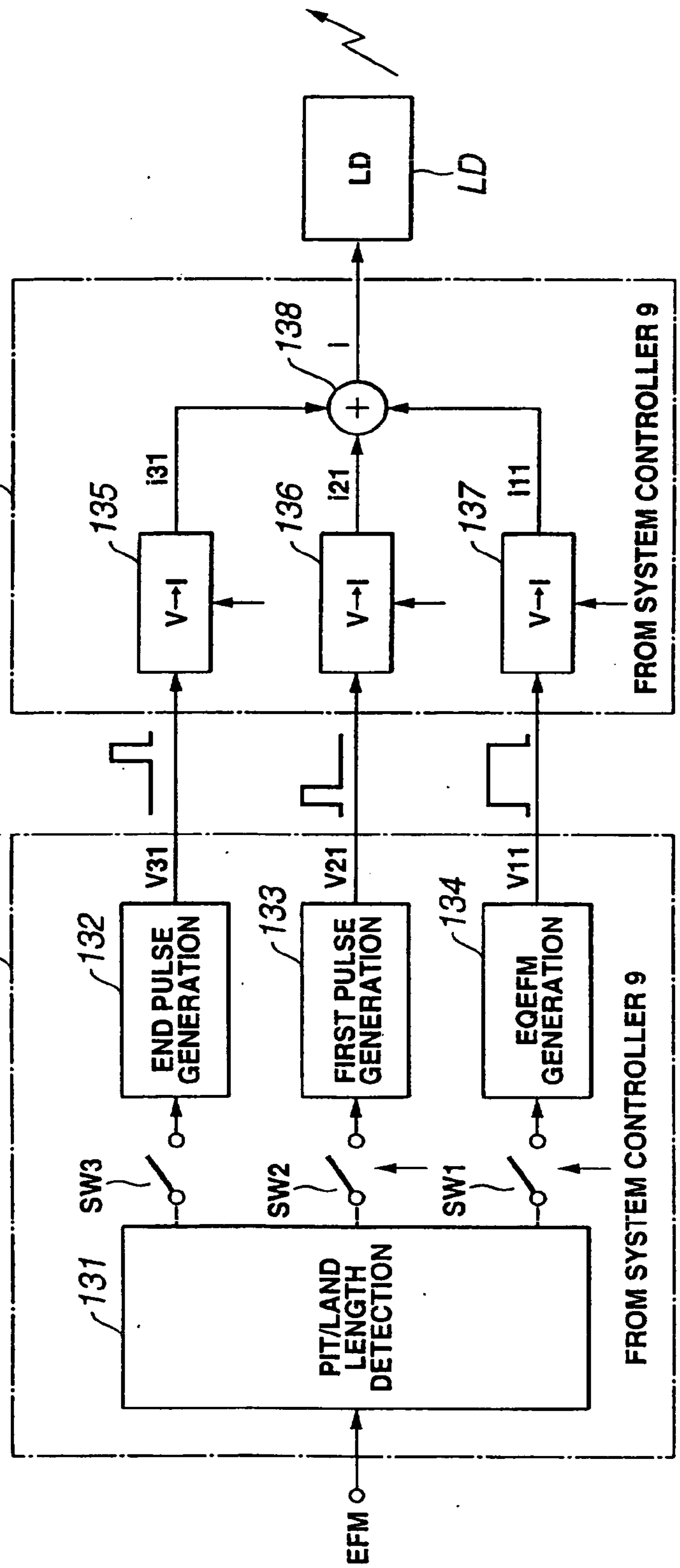

EFM
121
131
PIT/LAND LENGTH DETECTION
SW3
SW2
SW1
132
END PULSE GENERATION
133
FIRST PULSE GENERATION
134
EQEFM GENERATION
V31
V21
V11
FROM SYSTEM CONTROLLER 9
118
135
V→I
136
V→I
137
V→I
I31
I21
I11
138
I
FROM SYSTEM CONTROLLER 9
LD
LD

FIG.15

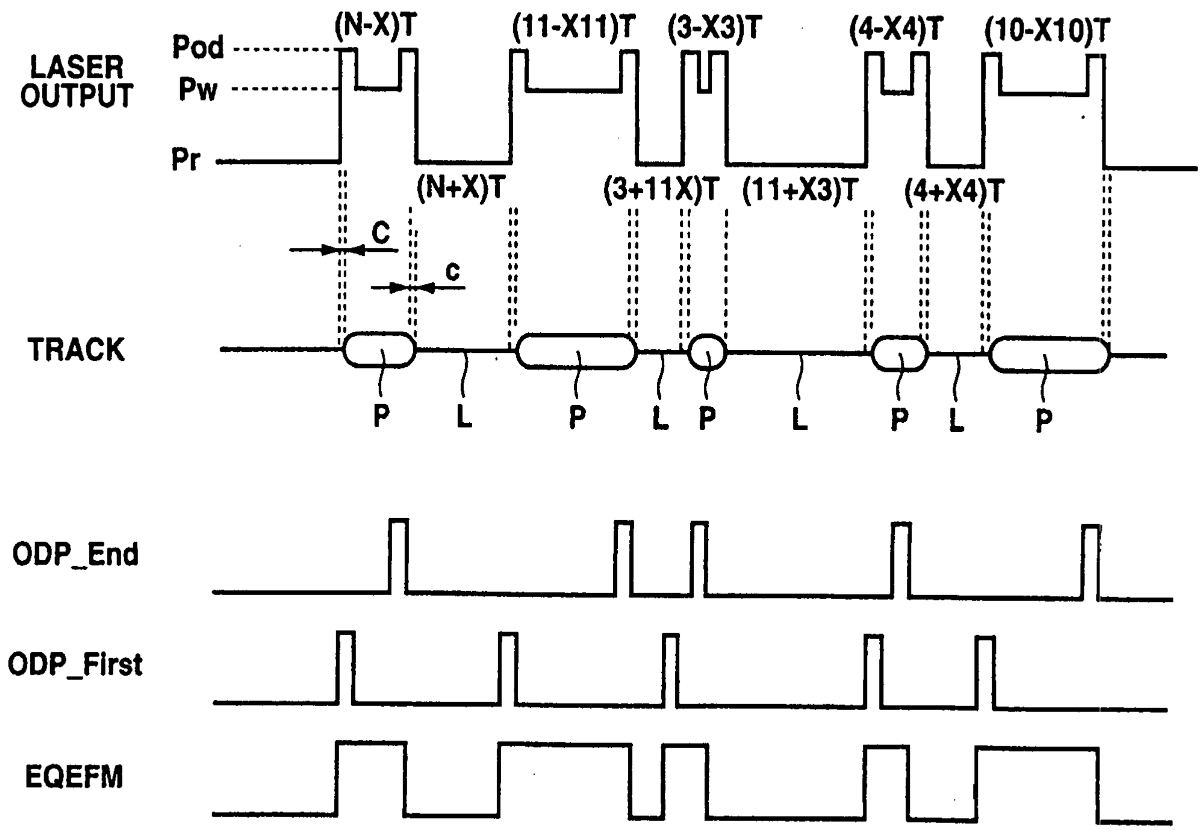


FIG.16A
FIG.16B
FIG.16C
FIG.16D
FIG.16E

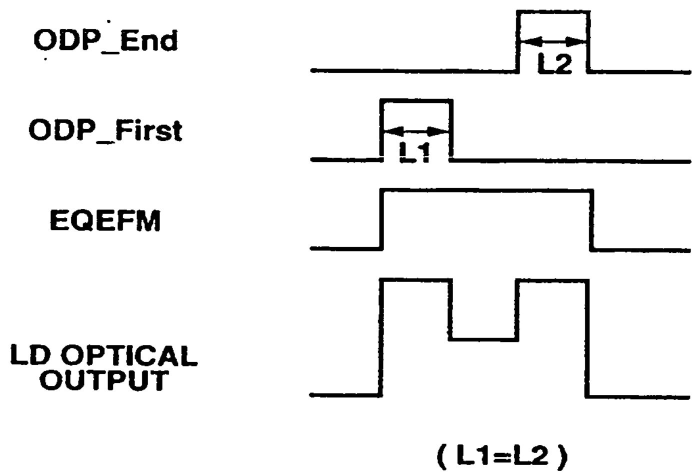

ODP_End
L2
ODP_First
L1
EQEFM
LD OPTICAL OUTPUT
(L1=L2)

FIG.17

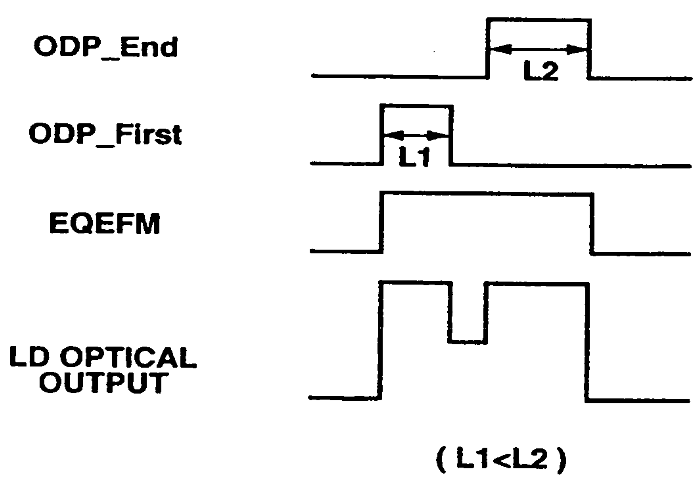

ODP_End
L2
ODP_First
L1
EQEFM
LD OPTICAL OUTPUT
(L1<L2)

FIG.18

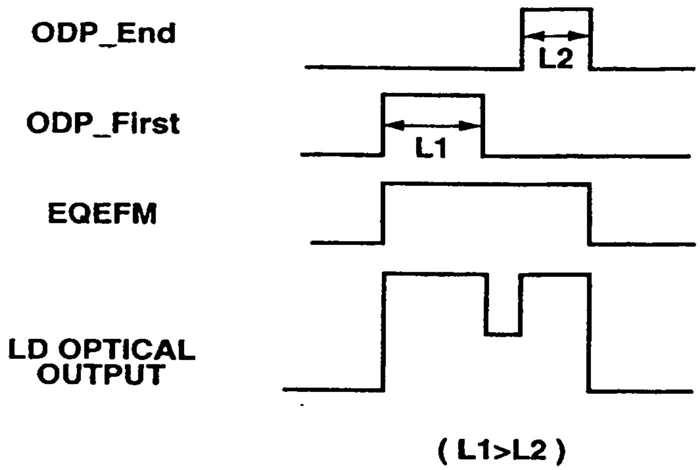

ODP_End
L2
ODP_First
L1
EQEFM
LD OPTICAL OUTPUT
(L1>L2)

FIG.19

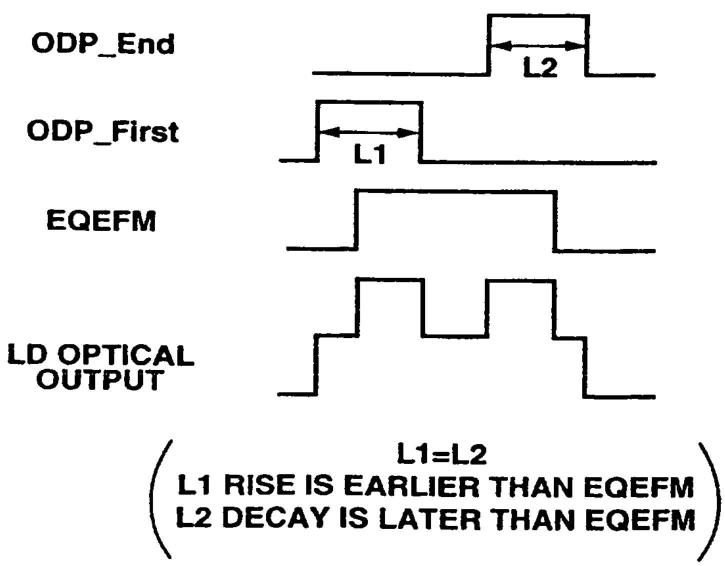

ODP_End
L2
ODP_First
L1
EQEFM
LD OPTICAL OUTPUT
L1=L2
L1 RISE IS EARLIER THAN EQEFM
L2 DECAY IS LATER THAN EQEFM

FIG.20

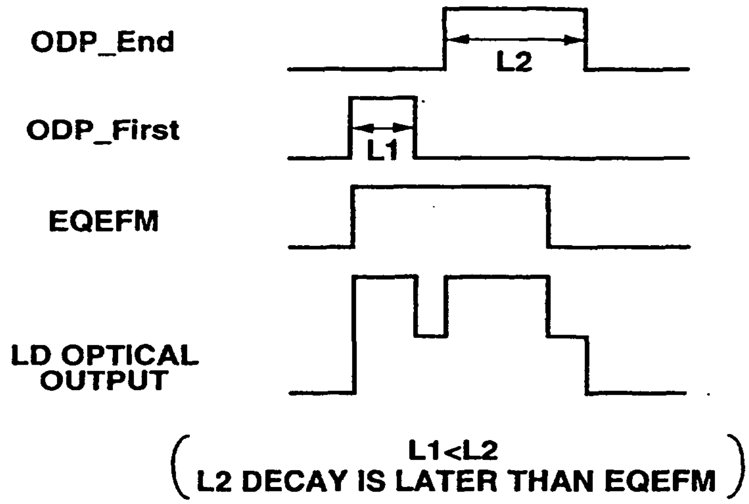

ODP_End
L2
ODP_First
L1
EQEFM
LD OPTICAL OUTPUT
L1<L2
L2 DECAY IS LATER THAN EQEFM

FIG.21

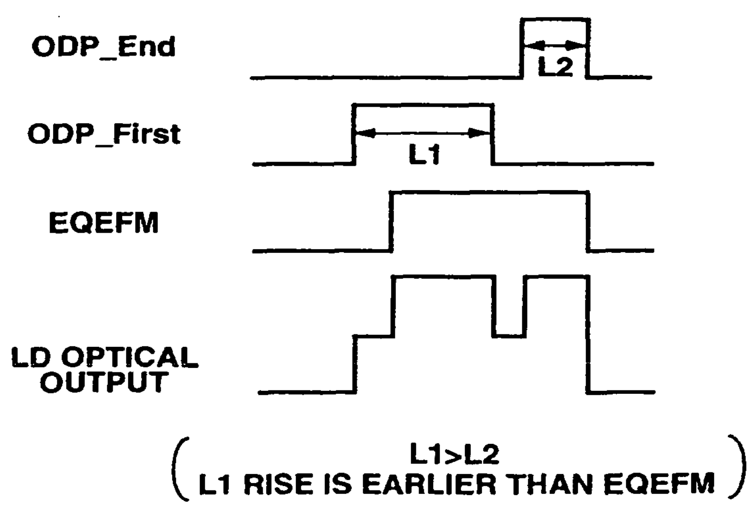

ODP_End
L2
ODP_First
L1
EQEFM
LD OPTICAL OUTPUT
L1>L2
L1 RISE IS EARLIER THAN EQEFM

FIG.22